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PRESENT STATUS OF STAPEDOLYSIS (STAPES MOBILIZATION).*†‡

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It is difficult to assess the present status of the revived stapes mobilization (stapedolysis) procedure for otosclerosis. Barely two years have passed since Rosen[1] re-awakened our interest in the direct approach to the ankylosed stapes footplate. Since then otologists have begun to reconsider the approach which first advocated by Kessel[2] in 1876, became well advanced by 1890, when Miot[3] published some astute observations on the subject.

In the past year much heat has been generated, but little light shed on this otologic chapter. The earlier failures in the stapes approach, and recent refinements and successes in fenestration surgery, obviously created a skeptical attitude toward this revival.

A presentation of my present views on surgical physiology, selection of candidates and technique will be followed by an analysis of results in 189 cases.

I. SURGICAL PHYSIOLOGY.

Basic acoustic and anatomico-pathological differences exist between fenestration and stapedolysis. Since the fenestration operation is a detour procedure, and one in which the approach to the perilymphatic vestibule is remote from the otosclerotic

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focus, it may be regarded as a precise procedure for a specific purpose: namely, the rerouting of acoustic energy across a new air-perilymph junction to take the place of the closed oval window footplate region. The stapedolysis approach, however, directly attacks the very pathologic lesion which is responsible for the interruption of sound transmission across the natural oval window air-perilymph junction. Since the otosclerotic disease process may occur in many varieties and in many quantitative degrees at this junction, no one operative procedure can be standardized and used in all cases in the same manner as the fenestration operation. This makes necessary a different conception of surgical attack for the direct or stapedolysis approach.

In the treatment of otosclerosis, the fenestration operation has a far more limited audiologic application than the stapedolysis approach. A physiologic deficit must occur in fenestration surgery, due to the almost complete loss of the impedance matching mechanism of the middle ear; therefore, the postoperative air conduction will seldom be better than 15 db below the preoperative bone conduction level. Since an average of 30 db loss in the speech frequencies is the lowest limit adequate for restoration of practical unaided hearing, it is necessary to start out with a good bone conduction level, one not lower than 15 to 20 db in the speech frequencies.

In stapedolysis the surgical objective is lysis of obstruction in the stapediovestibular junction so that remobilization of the footplate to air-borne sound may occur. Under ideal conditions, this approach completely respects the integrity of the tympanic membrane-ossicular chain mechanism so that the mechanical advantage of this impedance matching mechanism is not lost.

Upon achievement of maximum lysis surgically, it is possible to expect an almost complete eradication of the conductive block and an elimination of the bone-air gap, so that hearing postoperatively approaches the preoperative bone conduction level. In some cases this level will even be surpassed due to improved perilymph mobility.

Even though there is no minimal physiological deficit in stapedolysis comparable to that in fenestration, it must be

recognized that deficits do occur. These deficits are either of pathologic origin or due to surgical complications.

II. SELECTION OF CANDIDATES.

Because of the above physiologic differences, one can expect greater flexibility in the application of stapedolysis, clinically. Thus, the patient with a 30 db bone conduction level and a 70 db air conduction level may still achieve a postoperative 30 db air conduction level (and practical unaided hearing) if there is no pathologic reason to interfere with "success". Such a result is usually not possible in the fenestration approach which, if successful, would not promise better than a 45 db level.

Another difference exists in selection of candidates. In fenestration surgery we were confined to the limited objective of the 30 db level for practical unaided hearing, because the surgical magnitude of the procedure made it undesirable to consider it in the majority of poor candidates where it could not possibly promise this 30 db objective.

In marked contrast, however, the lesser complexity of the stapedolysis procedure (insofar as the patient is concerned) and the lack of a minimal physiological deficit, make it advisable to consider surgical intervention even where it is impossible to expect the 30 db level. Thus the patient with 45 db bone conduction and 85 db air conduction who experiences discomfort, even with maximum output of a hearing aid, can look forward to a great improvement in his hearing status if a successful stapedolysis procedure brings his air conduction threshold back to the 45 db level. Under these circumstances (following a surgical procedure requiring one day of hospitalization and very little postoperative care) this patient can not only utilize amplification with better results but can also get along without amplification in certain circumstances which would previously have been impossible. Such a patient could have hoped at best for a 55 db or 60 db air conduction level following a successful fenestration operation.

In general, therefore, in the present early status of stapedolysis, one might consider as a candidate any patient with

otosclerosis who has no specific anatomic or pathologic contraindications, and who has a bone conduction level of not lower than 45 db with a significant bone-air gap in the speech frequencies.

III. STAPEDOLYSIS—BASIC PRINCIPLES.

Since the surgical attack in stapedolysis is direct, and since the otosclerotic footplate lesions are various in degree and character, it is obvious that multiple maneuvers must be available to cope with the variations in the disease process. It is now well known that it is possible to apply a steady or intermittent force to the stapes neck and frequently achieve a very satisfactory mobilization by a surgically induced fracture of the footplate bony lesion, allowing restoration of function; but in this ungraded and unguided application of force it is also quite possible to dislocate the incudo-stapedial joint permanently, and to fracture one or both crura if the footplate fixation is of major degree. This "all or none" method of surgical attack does not require audiometric guidance but relies upon digital and visual monitoring of the force application.

The ultimate physiological objective in stapedolysis depends upon two factors: *a.* satisfactory lysis of the footplate obstruction, and *b.* maintenance of the functioning middle ear mechanism. It is a poor victory indeed to obtain complete footplate lysis and at the same time lose the middle ear mechanism impedance matching advantage.

In order to apply force to the footplate region adequate to produce lysis and yet insufficient to disarticulate the incus from the stapes or break the stapedial crura, it is necessary to have some method of "titration" so that the application of force can be controlled. It is obvious, of course, that such titration must be audiometric, since visual or digital impressions are unreliable in the relatively blind application of force to a small lesion which actually is primarily located on the vestibular aspect of the lateral labyrinthine wall.

The surgical audiometric technique which has been described previously by Goodhill[11] depends upon four basic steps, which may be summarized as follows:

Step No. 1—Middle Ear Closed.

This first step is performed following the completion of the flap elevation and the enucleation of the tympanic fibrous annulus from the tympanic sulcus so that the middle ear has been opened and then temporarily closed again with the skin-periosteal-tympanic membrane flap approximated to the original incision. The necessity of deferring this step until the middle ear has been opened and then again closed is to obtain a realistic audiometric graph of the traumatized tympanic membrane, annular flap, and slightly disturbed incudo-malleolar mass (as a result of the manipulation). To do this step prior to the incision and elevation would not give a true measurement for comparison with Step No. 4.

Step No. 2—Middle Ear Open.

The second step is made immediately following the first step by simply reopening the middle ear by rolling the annular flap and posterior half of the tympanic membrane anteriorly, exposing the posterior half of the middle ear with its usual landmarks. This is the step which will be used for comparison with critical Step No. 3.

Step No. 3.

This step is performed upon completion of an attempted lysis maneuver through the incudo-stapedial mass. This may involve one or more maneuvers, but it is done at a time when, in the judgment of the surgeon, sufficient stapedial motion has been produced to indicate some change. This judgment can be acquired only by experience. Subjective responses of the patient may also be used as an index.

This Step No. 3 will be compared directly with Step No. 2 for evidence of threshold shift. This is the critical point of the whole surgical procedure and may require several repetitions according to the guidance obtained by the *nomographic technique*[12] to be described. The amount of improvement which can be considered significant depends on several factors, and no set number of decibels can be considered a minimum desideratum.

Step No. 4.

Step No. 4 is performed when the posterior skin-tympanic membrane flap is replaced, as in Step No. 1, and a comparison is made between these two steps. Here again the guidance in desired degree of threshold shift will be obtained by means of nomographic information.

Because the bone-air gap is highly variable in individual cases, it is obvious that no set decibel threshold shift can be utilized as a guide, but some ratio must be available for predictive reasoning during the surgical procedure. Recently, therefore, a number of recent changes in surgical audiometry were introduced. To obtain an average threshold amplitude for comparative purposes, the "equivalent speech reception threshold" advocated by Fletcher[3] is used. This formula selects the two best responses of the 500, 1000, and 2000 cycle thresholds and averages these responses. This "equivalent SRT" is the single "figure of merit" for easy comparison of the different surgical steps. We have found the Fletcher equivalent SRT quite comparable with SRTs obtained from conventional spondee word lists.

In order to obtain a reasonably reliable method of surgical guidance, a surgical audiometric nomograph,* utilizing the Fletcher formula, has been devised. This nomograph uses the single SRT figure for bone conduction, for preoperative air conduction, for each surgical audiometric step and for postoperative air conduction. The nomograph is constructed as illustrated in Fig. 1. The ordinates (vertical axis) of the graph are in the familiar decibel ratio with respect to the normal audiometric zero level. The abscissa (horizontal axis) divisions are made equal to the ordinate, even though they represent only the discrete steps in audiometry. The preoperative bone conduction is shown by a dashed horizontal line at the proper ordinate value, using the one equivalent SRT figure of merit. This establishes the surgical objective, or the expected air conduction level, if the operation is to be an unqualified success by one of our proposed standards. The abscissae consist basically of six positions, which are used to indicate—first, the preoperative A. C. level; then the four surgical audio-

* Nomograph, a graphic law (nomos-law).

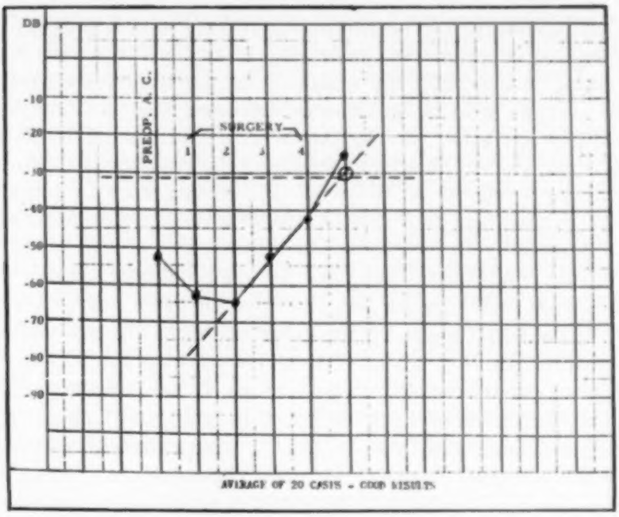


Fig. 1. Average nomographic plot of surgical audiometry in 20 successful cases.

metric steps; and finally the position of postoperative A. C. level which will be charted two weeks following surgery. Where more than one test is made at Step No. 3 the results are shown on the same abscissa line labeled (a), (b), (c), etc., the last one being the significant figure. Step No. 4 may be treated in the same manner when necessary.

The crucial stage in this operative approach is Step No. 3, where the surgeon has already produced some degree of force application, and perhaps some degree of lysis of the footplate ankylosis. It is at this point that a decision must be made as to whether to terminate the procedure or continue further. Thus a minimal improvement in hearing might erroneously lead the surgeon to consider that his efforts have been adequate, and he may conclude the procedure without attaining the ideal gain which could have been expected in this particular patient. On the other hand, excessive force applications at this point without adequate audiometric control may be disastrous by either destruction of one or both crura or permanent dislocation of the incudo-stapedial joint.

The nomographic technique, therefore, makes possible the utilization of predictive reasoning at this critical Step No. 3 in order to ascertain the adequacy of the lysis force exerted. The average gain to be expected between Step No. 2 and the ideal postoperative air conduction level can be roughly divided into three parts. This is, in general, true whether the required total improvement is 15 or 45 db, or any step in between. Thus, where the coordinates are equally spaced, a straight line diagonally drawn from the intersection of the preoperative bone conduction level (and the expected postoperative air conduction level) to the No. 2 step of surgery will be divided into three equal parts by the intersection of the abscissae of surgical Steps Nos. 3 and 4; therefore, regardless of whether the bone conduction threshold is high or low, and regardless of the threshold of Step No. 2, this straight diagonal line, which can be dotted in as in Fig. 1, is an excellent indication of where surgical steps Nos. 3 and 4 should appear. Thus, following lysis maneuvers, if Step No. 3 falls near or above the line (that is, to its left) it is probable that Step No. 4 and the postoperative air conduction will follow suit, providing there are no operative or postoperative complications. The reason why the expected gains between Steps Nos. 3 and 4, and between Step No. 4 and postoperative A. C. level are roughly equal to the gain between Steps Nos. 2 and 3, is due to the fact that the efficiency of the ear drum-ossicular chain mechanism as an acoustic transducer is greatest when working into the load of a normally mobile stapes. Thus, the impedance mismatch between the drum and stapes footplate is an approximate function of the degree of fixation of the latter. The level of Step No. 4 is materially influenced by the precision with which the middle ear is closed and the drum reapproximated to its sulcus attachment. If the threshold at Step No. 4 falls on or above the straight diagonal guide line, the probability of postoperative success is great.

IV. TECHNIQUE OF STAPEDOLYSIS—PRESENT STATUS.

Several features of the stapedolysis technique used by the author remain essentially unchanged since the original description.[5] The basic steps may be summarized briefly as follows:

Preoperative medication is usually limited to light barbiturates. Skin preparation relies mainly upon the use of aqueous zephiran in the canal, not only for antisepsis but also for the purpose of increasing tympanic membrane edema for easier enucleation. The entire surgical procedure is done through an ear speculum under block anesthesia. A generous omega-shaped skin flap is made on the posterior aspect of the auditory canal and the tympanic cavity opened adequately in its posterior half. Bone is removed from the postero-superior annular quadrant by the use of a burr and curette, if necessary, in order to obtain adequate exposure of the incudo-stapedial joint. Surgical audiometry is performed as previously described, using the four steps and the nomographic technique in surgical guidance.

The actual technical maneuvers necessary for adequate lysis depend primarily upon the pathologic status of the footplate region. Since the objectives are dual, namely, liberation of footplate ankylosis and preservation of middle ear impedance matching mechanism, both must be constantly considered in every operative maneuver.

A.—STABLE INCUDO-STAPEDIAL JOINT AND RIGID CRURA.

In the presence of a stable incudo-stapedial joint, with rigid crura, as determined by palpation and visual observation, the initial force application is usually trans-incudal (see Figs. 2 and 3). The needle probe (see Fig. 4) is engaged within the periosteum of the lenticular incudal process and is used to palpate for incudo-stapedial stability and degree of footplate fixation. If force application seems feasible by this technique, interrupted delicate digital vibrato pressures are transmitted through the incudo-stapedial joint to the footplate region in a direction determined largely by resistance encountered. In most instances, it will be found that the major stiffness or fixation is at the anterior limb of the footplate. Accordingly, the direction of force is usually in a posterior direction, namely, toward the posterior limb of the footplate in order to produce a surgical fracture either through the otosclerotic bone in the capsular region or through the footplate itself, thus allowing normal resumption of footplate excursions in response to acoustic energy; furthermore, the stapedial tendon in most

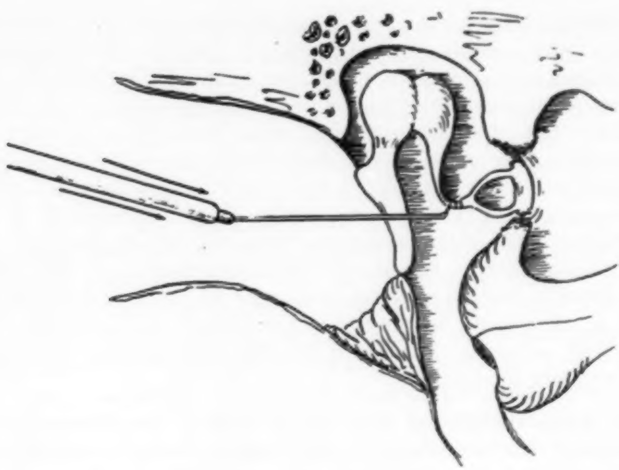


Fig. 2. Diagrammatic representation of trans-incudal stapedolysis force application.

instances will serve as a protective anchor to prevent excessive medial transmission of force with possible vestibular displacement of the fractured footplate. In some instances the direction of force will be in a superior (cephalic) direction, toward the horizontal limb of the VIIth nerve, if greatest resistance is encountered in that direction on palpation. Incudo-stapedial dislocation will occur more frequently when force is in an inferior direction (caudal), pulling the stapedial capitulum away from the anchored incus. There appears to be greater tolerance for slight rotation of the stapes superiorly than inferiorly. Thus, a combined maneuver in a postero-superior direction will be effective in a majority of cases.

When preliminary palpation reveals a degree of fixation too great for lysis by simple digital force, the next step is the use of the microvibrator.

The microvibrator consists of a dental handpiece with an angulated "amalpak" automatic hammer attachment, to which is added an offset right angle probe to transmit hammer-like percussion forces (see Fig. 5). The rate of motion of the vibra-

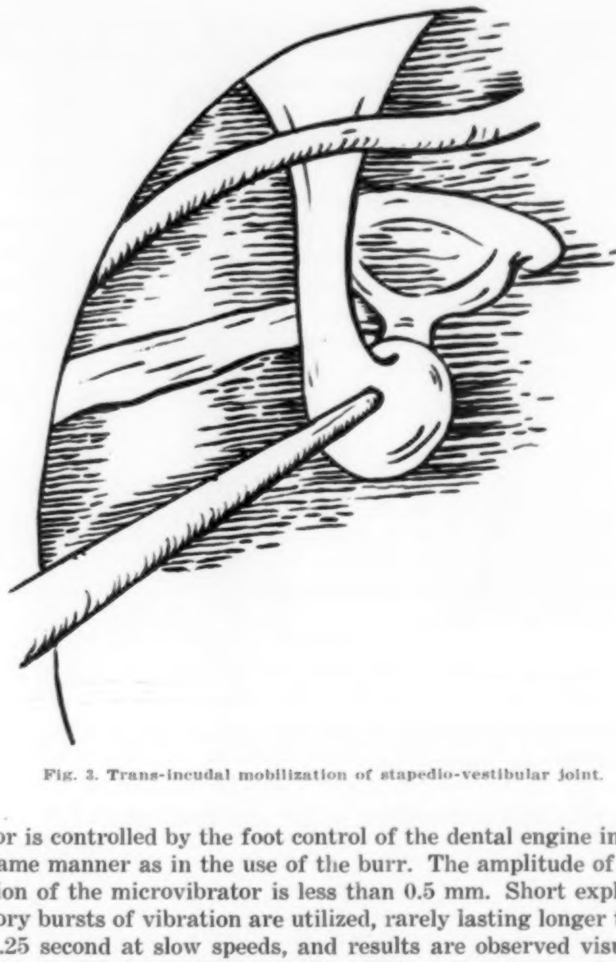


Fig. 3. Trans-incudal mobilization of stapedio-vestibular joint.

tor is controlled by the foot control of the dental engine in the same manner as in the use of the burr. The amplitude of motion of the microvibrator is less than 0.5 mm. Short exploratory bursts of vibration are utilized, rarely lasting longer than 0.25 second at slow speeds, and results are observed visually and monitored audiometrically. This microvibrator has a needle point and is also inserted into the lenticular process of the incus. Force is transmitted, as before, in a postero-superior direction, in short bursts. Frequently, a rigidly fixed footplate which would not respond to digital force will respond quickly to one or two short microvibrator bursts, following

Fig. 4. Needle probe.

Fig. 5. Microvibrator components.

which it may be possible to obtain further footplate lysis by further digital manipulation.

B.—LOOSE INCUDO-STAPEDIAL JOINT AND RIGID CRURA.

In the event that diagnostic palpation reveals a loose incudo-stapedial joint, one easily subject to dislocation, force is applied directly to the stapedial capitulum in order to prevent irreversible incudo-stapedial dislocation. A number of early attempts to cement such joints with a fast setting plastic cement "pentocryl" were only sporadically successful. Further studies to solve this problem are underway.

In such cases, the lenticular process is moved slightly away from its insertion upon the capitulum, and only sufficient capitulum area is exposed to permit application of the needle probe

directly into capitular bone. When this has been successfully accomplished, gentle digital vibrato pressures are applied in the same manner as previously used in the trans-incudal approach. If such pressures are successful in producing lysis, the lenticular process is reapplied to the capitulum and the operation concluded.

If the rigidity of the footplate is so great that digital motion will be inadequate for adequate force transference, the microvibrator is substituted for the needle probe into the capitular area for direct application of microvibrator force in a posterosuperior direction. Usually, this maneuver will free even a markedly fixed footplate. Supplementary needle probe manipulation through the capitulum may be employed for further footplate lysis.

C.—ATROPHIC NON-RIGID CRURA.

In the event that palpation reveals that the crura are atrophic and elastic, or in the event that one or both crura have been surgically fractured, it is not advisable to persist in application of force either to the incus or to the capitulum. In such a situation, direct footplate lysis attempts are indicated.

D.—FOOTPLATE LYSIS TECHNIQUES.

It is difficult adequately to visualize the stapes footplate. In some cases it can be seen easily with the ordinary loupe and light, and in others with existing microscopic techniques. A significant number remains where visualization is impossible, at the present; nevertheless, surgical approach to the footplate may still be made safely, in most cases, and future improvements in stapedolysis techniques may well be based upon a *primary* application of force to the footplate region. At the present state of our experience, however, it remains the final region for lysis attempts in stapedolysis surgery. It is indicated not only in the condition where crura are atrophic, nonrigid, elastic or fractured, but also where extreme fixation or replacement has not permitted lysis by either needle probe or microvibrator through incus or through capitulum.

The simplest transmission of force to the footplate is obtained through a fine dull probe, which can be placed in the intercrural space following the curve of the anterior surface

of the posterior crus. The tip of the probe will inevitably meet resistance in the footplate region and at that point gentle to and fro vibratory motion may be exerted, frequently yielding fairly prompt lysis. If such is obtained, as determined by surgical audiometry, it may still be possible to maintain impedance matching, even though the crura are elastic or partially fractured, so long as some degree of continuity exists mechanically between the tympanic membrane and the footplate region. Ideally, of course, one seeks a perfect transmission of force along the tympanic membrane-ossicular chain mechanism, but even a partial transmission under inefficient conditions is advantageous and should not be ignored.

In the event that footplate motion with the simple dull probe is ineffective, a dull microvibrator may be used in the same region, following the same placement technique and using the same type of short energy bursts, rarely lasting more than 0.25 second, and applied at a low frequency by rheostat foot control. One or two such bursts of energy application may be sufficient to produce lysis; or it may be necessary to shift the locus of application with the microvibrator in an anterior direction if posterior application fails. The footplate may have varying areas in degree of otosclerotic fixation, thus lysis may occur more readily in one region than in another; therefore, careful exploration of the footplate region is advisable before one concludes that lysis is impossible.

As a final step, if neither probe nor microvibrator force application to the footplate region is effective, gentle needle currettage of the footplate region is justified. Such curettage techniques will frequently loosen small areas of osteogenetic fixation and may allow footplate mobility which prior to that was impossible. Up to the present time, footplate curettage remains the final step in stapedolysis techniques. If there is no audiometric evidence of lysis following footplate curettage, the procedure should be concluded.

(It should be noted that successful perilymph mobilization through footplate lysis techniques occasionally produces vertigo which may last from several hours to several days, accompanied by nystagmus, nausea and vomiting. It is usually controlled well by intramuscular Dramamine, 50 mgm. every four hours.)

E.—CLOSURE.

Upon the completion of the lysis maneuvers and the demonstrations of final audiometric status, regardless of success or failure, the operative wound is finally closed. Meticulous removal of blood from the tympanic cavity is urgently indicated, and the tympanic membrane and posterior skin flap are gently replaced into their preoperative positions. The packing consists of rayon saline soaked strips to cover the skin incision, and small wedges of cellulose sponge saturated in neocortisone ointment to exert slight centrifugal pressure and keep the rayon strips in place.

F.—SURGICAL PROBLEMS.

1. Incudo-stapedial Dislocation.

As mentioned above, incudo-stapedial dislocation may occur during the course of trans-incudal lysis attempts. Such dislocations appear to be even more frequent following lysis attempts via the stapedial neck, according to the Rosen technique. When dislocation occurs, it usually is of no significance providing the forces are not great and providing that there is only very slight displacement of the two bones. It is usually quite simple to reapply the lenticular process to the capitulum of the stapes and obtain very good contact and union, so that trans-ossicular acoustic transmission continues quite efficiently. Occasionally in cases of rather wide displacement of the ossicles it has been possible to replace the lenticular process contact with the capitulum by actually producing a surgical greenstick fracture of the incus and bending it a millimeter or two in order to have it approach and meet with the stapes capitulum.

Incudo-stapedial dislocation should not be looked upon as an unimportant complication. Deprivation of the impedance matching action of the tympanic membranes-ossicular chain mechanism produces a serious loss in acoustic energy and should be avoided if at all possible in all circumstances.

In some cases, incudo-stapedial dislocation is probably accompanied by some degree of incudo-malleolar joint disruption, and perhaps by partial detachment of malleus handle from

its tympanic membrane attachment. This, of course, seriously impairs the mechanical advantage of the middle ear mechanism, and may even create of it an obstructive lesion. It has been observed, in a few cases, that when extensive incudo-stapedial dislocation occurred, thresholds were better when the middle ear was open than when it was closed. It is possible in such instances that, through phase reversal, acoustic transmission was more effective via the round window, with decreased efficiency when the useless drum closed the tympanic air space and blocked the tympanic air pathways to the round window.

2. Crural Injuries.

In the application of force to the incudo-stapedial area it is inevitable that crural damage will be inflicted in some cases. Such is the case in all present techniques. It is the hope of the author that this surgical complication will eventually be eliminated completely.

The nature of crural injuries will vary with the basic pathologic status and the type and degree of force used. Such injuries may range from a simple partial greenstick fracture of one crus to complete fracture of both crura and ablation of the capitulum and crura from the footplate remnant.

Ideally, of course, crural injuries are best treated by prevention. When they occur, however, attempts should be made to replace the fragments in such positions that healing will be encouraged. Undoubtedly healing does occur in many cases, but it is not the rule probably. Observations on revisions of stapedolysis will help to clarify this point.

Frequently an injury will occur to one crus without involving the other. In such cases it is still possible to get physiologic continuity of energy transmission along the intact crus with successful impedance matching action.

(As an interesting comment, E. P. Fowler, Jr.,* now advocates anterior crurotomy as a preferred technique in cases limited to anterior footplate fixation. He believes that this liberation allows an effective footplate fracture and preserva-

* Personal communication.

tion of an acoustic pathway along the posterior crus which is still connected to the mobile footplate remnant.

3. Hemorrhage.

Minor bleeding will frequently occur from the canal in the region of the incision, and will start either from skin or periosteal margins, or from small bone vessels. It usually subsides promptly with pressure, but it may persist. If it persists, it is a very annoying surgical problem. It may obscure the tympanic field. It may distort surgical audiometry by clotting in the oval or round window regions. If it remains as a clot it may become a precursor for tympanic fibrosis.

Bleeding should be controlled, either by pressure with epinephrine soaked cotton pledgets or by electrocoagulation of bleeding skin or periosteal vessels. The use of a polishing burr to stop small bone bleeders may be necessary.

4. Vertigo—Operative.

Momentary vertigo may be experienced by the patient during some lysis maneuvers. The patient will complain of a sense of instantaneous imbalance, which usually disappears when force is stopped. While it is not uncommon to obtain vertiginous symptoms in successful lysis, its absence is also quite common. Consequently, it is not an invaluable guide to lysis maneuvers. Apparently individual vestibular sensitivity is quite variable, and the transmission of perilymph motion from the oval window to the vestibular system is not consistently productive of vertigo. The proximity of utricle and saccule in individual cases may be related to variations in vertigo. Very rarely such operative vertigo may cause nausea and vomiting, which is very fleeting.

5. Removal of Bone Dust.

When it is necessary to remove portions of the postero-superior bony annular quadrant for better incudo-stapedial exposure, the use of a burnishing burr on a contra-angle attachment is frequently necessary. The bone dust which forms following the use of the burr should be quickly removed meticulously by the use of dry suction. This, of course, may slow up

the procedure considerably, but it is preferred to the accumulation of large quantities of bone dust with the subsequent need for irrigation and massive suction. Irrigation is not dangerous, but it upsets some patients because of the caloric response.

6. Perforations.

It is not unusual to perforate or simply tear the tympanic membrane in the postero-inferior quadrant, particularly a very transparent atrophic tympanic membrane, during the enucleation. In such cases, the mere elevation of the skin flap-tympanic membrane segment is sufficient to produce a tear close to the annular margin in the postero-inferior quadrant. This is not a serious occurrence, since healing of the perforation almost always occurs.

In all cases, however, it is my practice to close the perforation with a small, thin, free skin graft taken from the incision margin, placed over the perforated or torn area, and covered with a rayon strip. Such a skin graft will usually take within one week with complete healing.

G.—POSTOPERATIVE CARE.

1. Antibiotics.

It is advisable to use prophylactic antibiotics in all cases. It is particularly necessary where a patient has been wearing a hearing aid in the operated ear. Such skin is liable to be rather edematous and of poor vitality, and external otitis, as well as otitis media may occur following surgery. If the patient has no antibiotic sensitivities, it is our practice to administer Bicillin 600,000 units intramuscularly on the morning of the operative day, and to follow this with oral tetracycline 250 mgm. t.i.d. for five days. Such antibiotic prophylaxis appears to have been effective. We have had very few postoperative infections; none of which were significant. In allergic patients, other antibiotics or sulfonamides are employed.

2. Pain.

There is slight pain following this surgical procedure, but it is relieved by the use of aspirin, codein or demerol.

3. Ambulation.

The patient is allowed to be ambulatory as soon as the effects of the barbiturate medication have worn off.

4. Postoperative Vertigo.

Some patients will experience immediate slight or moderate vertigo, and in some instances nystagmus may be observed. Such vertigo is usually self limited within a few hours. If it is annoying it may be alleviated by small doses of Dramamine by mouth, occasionally by injection.

5. Hearing.

The hearing level in the operated ear, which may be elevated at the time of surgery, usually drops in the postoperative period, and may remain unchanged or even lower than the preoperative level until the packing is removed.

6. Removal of Packing.

The cellulose sponge and rayon packing is usually removed about the sixth day, after preliminary application of a detergent such as phisoderm or acidolate. This allows easy removal of the packing without bleeding. If bleeding occurs, the packing is undisturbed for another few days. When the packing has been completely removed it will usually be observed that the flap is well healed, the tympanic membrane appears mobile, and in most instances is translucent. Hearing is usually up if lysis was obtained. Hemotympanum and serous effusion are encountered only rarely postoperatively and usually subside spontaneously. No further dressing is employed after the packing has been removed. It is rarely necessary to treat the canal with any type of medication.

7. Tubotympanitis.

Tubotympanitis with retraction of the tympanic membrane may occur in the early postoperative period. If this does not clear spontaneously, gentle tubal inflation by the Politzer technique or catheter is carried out. This is rarely done before the fourteenth postoperative day. It should be done very gently and carefully, with visual observation of the drum to

avoid excessive pressures on the recently healed posterior skin-tympanic membrane flap.

8. Postoperative External Otitis.

Occasionally external otitis due to B. pyocyaneus or other organisms may occur. This is not uncommon in patients who have worn a hearing aid in the operated ear. The skin with poor vitality is easy prey for ordinary external environmental bacteria, and dermatitis of coccal origin may be encountered. Such external otitis is best treated by adequate cleansing with alcohol and local application of antibiotic preparations, weak acetic acid, or gentian violet.

V. POSTOPERATIVE RESULTS—AN ANALYSIS.

Since the results of stapes mobilization surgery are of very recent date, it is difficult to present a reasonably permanent evaluation at this early date. In the recent era, since Rosen[1] reported his first cases, only two years have elapsed, and the observations of this short period must be considered tentative and temporary; nevertheless, a number of deductions can be obtained from a careful analysis of immediate results. In this section immediate results will be presented first, followed by a discussion of analysis of failures, complications, reankyloses, revisions, fenestration of failures, revision of fenestrations by stapedolysis techniques, and finally the application of binaural stapedolysis. It must be emphasized again that these are very early observations and that long range studies may change the evaluations considerably in one direction or another.

The results of the author's series are based upon a study of more than 200 patients. Stable postoperative audiometric information is available on 189 cases. These 189 cases will be subjected to an analysis from varying points of view, and the results will be discussed and plotted graphically.

A.—IMMEDIATE POSTOPERATIVE RESULTS OF STAPEDOLYSIS.

1. Results of Other Observers.

A. Rosen[6] in April, 1955, reported results in 211 cases, which were divided into A, B, and C groups, depending upon

preoperative bone conductor levels. Of his total number of cases, apparently 37.3 per cent were classified as successes, 29.4 per cent having reached the 30 db level and 7.9 per cent the 35 db level. His criteria for success were typically fenestration criteria.

B. Meurman and Meurman,[7] in August, 1955, giving 63 primary results, reported good improvement in all groups (A, B and C) in 39.6 per cent and slight improvements in 19.1 per cent, a total of 58.7 per cent improved.

C. Scheer[8] in September, 1955, reported results in 100 cases. The footplate was found mobile in 3 per cent, the crura were fractured in 30 per cent, mobilization, successful and unsuccessful, was achieved in 67 per cent; 33 per cent of Scheer's patients were improved to the 30 db level; 13 per cent were improved to the level of preoperative bone conduction; a total of 7 per cent minor gains and successes amounted to 40 per cent. His total failures, including no gains and fractured crura, amounted to 57 per cent, and 3 per cent of the footplates were found mobile at the time of surgery.

2. Analysis of the Author's Cases—189 Cases.

As stated above, the observations of stapedolysis are based upon the author's experience in over 200 cases. Complete immediate postoperative audiometric data are available in 189 cases. These are considered in analysis, both as a total group of 189 and as two groups of the first 100 and the second 89 cases. This somewhat arbitrary division into two groups is based upon both chronological order and technical change. The entire group of 189 cases was operated upon between November, 1954, and December, 1955. The first 100 cases were done between November, 1954, and July, 1955; and the second group of 89 cases done between July, 1955, and December, 1955.

Undoubtedly, increased experience and technical changes were responsible for some of the differences, which will be observed in the following analyses. The technical changes included *a.* a more precise technique of lysis maneuvers based upon differences in gross pathologic variations, and *b.* the use of nomographic guidance in surgical audiometric techniques.

It is perhaps unfortunate in many ways that stapes mobilization (stapedolysis) is at present closely compared with fenestration, not only in technique but also in results. It is understandable that such comparisons are necessary in view of the history of the approaches; nevertheless, the fields covered by these two surgical techniques are different, although overlapping, and the results considered satisfactory are not necessarily the same in both approaches.

In fenestration surgery, the goal has usually been what is called practical or unaided hearing. While definitions of this objective vary, it is generally conceded that an air conduction level 30 db below the zero reference level is the lowest figure that can be used without qualification. The magnitude of the fenestration operation is such that it has usually not been considered advisable in cases where the predicted result could not attain this 30 db level objective.

Stapedolysis, with a much lower order of surgical trauma, has provided satisfactory gains in air conduction even in cases where the preoperative bone conduction was so low that unaided or practical hearing was obviously improbable. Thus, success in stapedolysis may be defined either *a.* in terms of the achievement of the practical hearing level (30 db) or *b.* in terms of the removal of the conductive block as is evidenced by a postoperative air conduction which reaches or surpasses preoperative bone conduction.

Thus, in all fairness, the title of "success" in stapedolysis surgery must be a dual concept, and must include either the achievement of the 30 db level or the elimination of the conductive block, as evidenced by an eradication of the bone-air gap.

The following definitions will clarify our concepts in evaluation of results:

A. "Thresholds".

The values of acoustic thresholds are stated in terms of the *equivalent SRT* using the Fletcher[4] formula (an average of the two best threshold responses at either 500, 1000 or 2000 cycles per second). Thus, while audiometric measurements are in 5 db

steps, the equivalent SRT values here used may vary in 2.5 db steps.

B. "No Change".

"No change" is used when the postoperative air conduction level is within plus or minus 5 db of preoperative air conduction.

C. "Losses".

"Losses" will be described where the last postoperative air conduction level was 7.5 db or more below preoperative air conduction.

D. "Partial Gains".

"Partial gains" will be described as cases in which the last postoperative air conduction is 7.5 db or more above the preoperative air conduction, but less than "success".

E. "Successes".

"Successes" will be defined as either *1.* cases in which the last postoperative air conduction is above the level, at the same level as, or not more than 7.5 db below preoperative bone conduction; or *2.* air conduction is not more than 30 db below the normal zero reference level. (Since audiometric measurements may vary by 5 db, and since our figures change in 2.5 db steps, the 7.5 db value is used as being a reasonable lower limit for "success".)

The following discussion will relate to the graphs which have been constructed in an attempt to analyze the results of stapedolysis, both as independent results and also in some cases in comparison with fenestration surgery. Thus differences and similarities between the two surgical approaches will be displayed in various types of candidates.

Fig. 6-A shows the distribution of the preoperative bone conduction levels of 189 candidates for stapedolysis. They are assembled in five db groups and are further segregated to indicate their probable classification as fenestration candidates. This histogram, which shows the number of cases in each

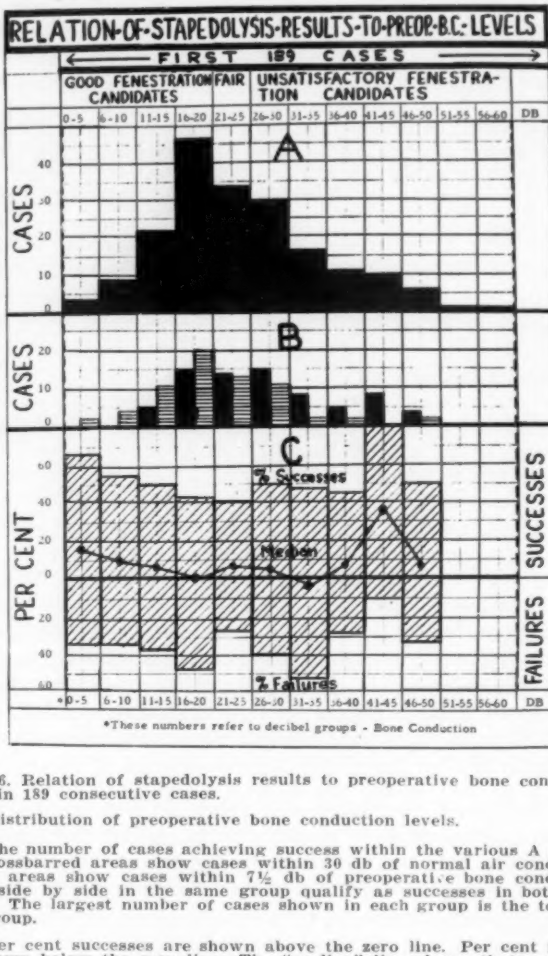


Fig. 6. Relation of stapedolysis results to preoperative bone conduction levels in 189 consecutive cases.

A—Distribution of preoperative bone conduction levels.

B—The number of cases achieving success within the various A groups. The crossbarred areas show cases within 30 db of normal air conduction. Shaded areas show cases within 7½ db of preoperative bone conduction. Areas side by side in the same group qualify as successes in both categories. The largest number of cases shown in each group is the total for that group.

C—Per cent successes are shown above the zero line. Per cent failures are shown below the zero line. The "median" line shows that results do not consistently favor any bone conduction, where there are significant numbers of samples.

group on the ordinate or vertical axis, demonstrates clearly the difference in the fields covered by the two surgical approaches. Assuming that ideal fenestration candidates are

those with bone conduction not poorer than 20 db, it will be seen that there were 80 such candidates in the 189 cases shown. In the group with bone conduction between 21 and 25 db below zero, there were 34 cases which would be considered fair candidates for fenestration surgery. This leaves a group of 75 patients who would have been considered unsatisfactory candidates for fenestration; nevertheless, an analysis of the data in Fig. 6-B indicates that in this last group of 75 patients considerable relief for the mixed type of deafness in otosclerosis can be expected from stapedolysis. Graph (see Fig. 6-B) shows the distribution and the two types of "success" in stapedolysis. Cases which are considered successful by virtue of having reached the postoperative air conduction level of 30 db or better are shown crossbarred; those which are considered successful because the conductive block (the bone-air gap) has been essentially removed regardless of the final air conduction level are shown in solid blocks. Where the two types of successes are shown side by side in a 5 db group, they qualify as successes under both definitions. For example, in the 16 to 20 db group, the total number of successes is 20, of which 15 qualify under both headings, and five cases qualify only in the 30 db class. As might be expected, the 30 db class is predominant in the 16 to 20 db group, and higher, while at preoperative bone conduction values below 20 db the elimination of the conductive block is most productive of success. It is an interesting fact, however, that there are many 30 db levels achieved from preoperative bone conduction groups that are much below the accepted fenestration candidate standards. It will be noted that 39 successful cases were obtained in this region of unsatisfactory fenestration candidates.

In Fig. 6-C, the percentage of successes and failures are shown relating A and B in various groups to see whether useful information might be obtained for candidate selection criteria in stapedolysis. Thus, total successes in each group are plotted in percentages above the zero reference line, and all failures, that is, all cases that failed to show over a five db gain in air conduction, are plotted below the reference line; partial gains are not considered. Where the midpoint of the resultant box falls on the zero line, the chances for success or failure are even; if the midpoint is above the line, the proba-

bility favors success or vice versa. Even if the criteria for success or failure are debatable in terms of db levels, the line connecting these midpoints will show any existing trend toward success or failure in these groups. In the groups from minus 10 db to minus 35 db, where there are sufficient cases to be significant, there appears to be little real advantage in any area of preoperative bone conduction. (The rise at both ends of the curve may disappear, or may be confirmed with more data.)

In Figs. 7 and 8, the entire group is analyzed in terms of air conduction gains and losses, and they are classified in terms

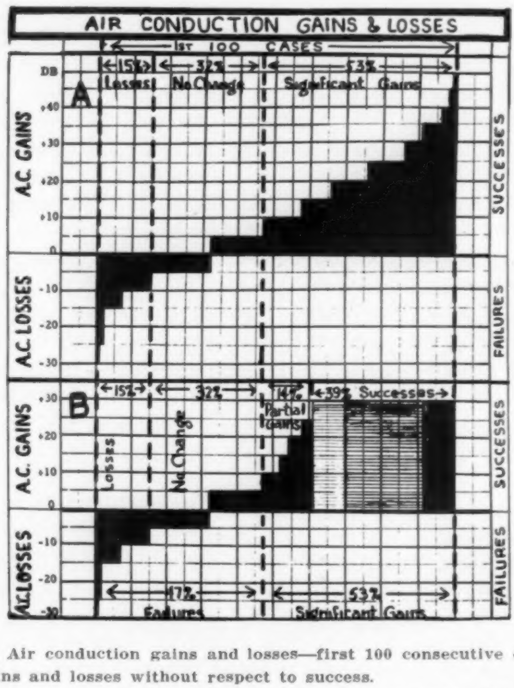


Fig. 7. Air conduction gains and losses—first 100 consecutive cases.

A—Gains and losses without respect to success.

B—Same as A except that all gains achieving success by either definition are shown as a group. White crossbarred areas are successes to 30 db level. Gray crossbarred areas are successes both to the 30 db level and in eradication of BC-AC gap. Solid areas are successes by eradication of BC-AC gap only.

of change from a zero level. Fig. 7 shows the results of the first consecutive 100 cases, and Fig. 8 shows the results in the second consecutive 89 cases.

Fig. 7 is plotted differently from the histogram (see Fig. 6), because the gains and losses to be displayed show most clearly when plotted above and below a zero reference line. Thus the db gains or losses are shown as ordinates on the vertical axis, and the number of cases in each five db group are shown on the horizontal zero axis. The first 100 cases shown in Fig. 7 may be analyzed as follows: In Fig. 7-A, the gains and losses

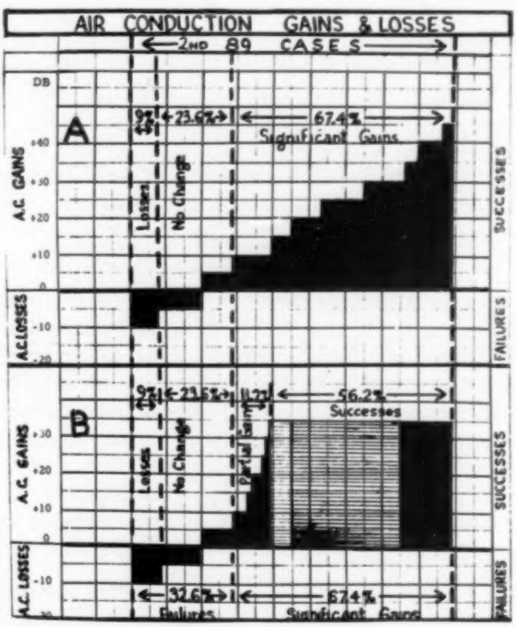


Fig. 8. Air conduction gains and losses—second group of 89 consecutive cases.

A—Gains and losses without respect to success (same as A in Fig. 7).

B—Same as A except "Successes" are shown as a group without regard to gain. Note the percentage increase in "Successes" over the first 100 cases shown in Fig. 6-B. White crossbarred areas are successes to 30 db level. Gray crossbarred areas are successes both to the 30 db level and in eradication by BC-AC gap. Solid areas are successes by eradication of BC-AC gap only.

show 15 per cent losses, 32 per cent no change, and 53 per cent with significant gains of 10 db or over.

Fig. 7-B shows the same data except that the successes are shown as a group without regard to actual db gain level, but they are divided into two categories of success, as previously described in Fig. 6-B. Thus, a total of 39 per cent of the cases in the first 100 may be classified as successes by one or both criteria of success; 14 per cent showed useful gains but were below the criteria necessary for success, and 47 per cent could be classified as failures (no change or losses).

In Fig. 8, which analyzes the second consecutive group of 89 cases, it will be noted with reference to Fig. 7 that the losses encountered are less severe, with none over 10 db, and are reduced from 15 per cent to 9 per cent. The no change category has been reduced from 32 per cent to 23.6 per cent. The feature of greatest importance, however, is the increase in the percentages of successes from 39 per cent to 56.2 per cent, with partial gains of 11.2 per cent. It is of interest to note that the increase in successes is more marked in the group with bone-air gap eradication rather than in the 30-db level group. This may reflect a definite improvement in technique.

It has been proposed by Davis and Walsh[9] that fenestration surgery be evaluated by the "surgical deficit" method, whereby the postoperative air conduction is compared to an expected value. This "expected" value is the mean resultant of a large number of cases, and for convenience is referred to preoperative bone conduction. Thus, they find that the expected postoperative level for fenestration as derived from 196 consecutive cases is 20 db below preoperative bone conduction. Shambaugh,[10] reporting on 164 consecutive cases, finds an expected value of 15 db below preoperative bone conduction.

Once the expected mean has been established for any given technique, or any given surgeon, the actual individual result is compared to the expected result, and the algebraic difference in decibels is stated as a surgical deficit. This method of evaluation has the advantage that it eliminates the more or less artificial definitions of success or failure and candidate classification, and permits the direct comparison of different techniques and procedures in surgery.

This surgical deficit technique is illustrated in its application to stapedolysis in Figs. 9-A and B, in which the relationship of postoperative air conduction to preoperative bone conduction is compared. In Fig. 9-A, the resultant histogram would rotate about a point 17 db below preoperative bone conduction. In the second group of 89 cases (see Fig. 9-B), im-

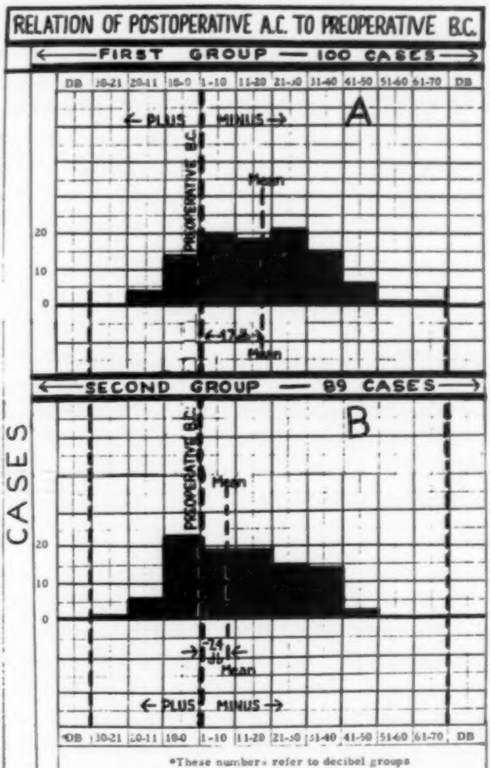


Fig. 9. Relation of postoperative air conduction to preoperative bone conduction. (The "Surgical Deficit" evaluation technique applied to Stapedolysis.)

A—First 100 consecutive cases. The "Surgical Deficit" is about 17 db with respect to the preoperative bone conduction.

B—The following 89 consecutive cases show an improvement of approximately 9½ db in the average deficit.

proved technique apparently has moved the median point up 9.5 db to about 7.5 db below preoperative bone conduction. It is, of course, hoped that surgical technique improvements will make for further advances, thus pushing the expected value further toward, or possibly even above preoperative bone conduction. It is of interest, however, that even at this early stage the expected result derived from unselected candidates is still 7.5 db better than the best presently accepted figure for fenestration of 15 db.

B.—COMPLICATIONS.

Complications of stapedolysis surgery are singularly rare. They may be divided into two groups: *a.* cases where hearing losses have occurred postoperatively, and *b.* other complications.

The first group *a.* has been described above. A number of threshold losses occurred as can be seen from a study of previous graphs; however, most of these losses were of academic interest only, since they did not materially change the social adequacy of the patient's hearing ability. No case of labyrinthitis or significant cochlear damage occurred in the author's series. All losses recorded were essentially conductive impairments. The absence of labyrinthitis and concomitant cochlear damage is in contrast to reports of some fenestration series.

The second group of miscellaneous complications is pleasantly small. No cases of facial paresis or paralysis were encountered. No cases of persistent vertigo were found. The longest postoperative duration of vertigo in one case was seven days. Two patients, among the first ten cases operated, had persistent dry central perforations. No cases of otorrhea occurred. Chorda tympani paresthesia was present temporarily in only a few patients. It has persisted in only one patient of the series. There were no surgical or post-surgical mortalities.

It may be stated in summary that the complications of stapedolysis are very few and minor.

C.—AN ANALYSIS OF OPERATIVE FAILURES.

Careful surgical records are kept (see Fig. 10) in all cases, along with the surgical audiometric nomograph. In an attempt to elicit specific causes for failures, all of the records, successes as well as failures, were studied in cases of unusual operative occurrences, which included *a.* trans-tympanic exposure problems; *b.* hemorrhage; *c.* tympanic perforations; *d.* incudostapedial dislocations; *e.* crural injuries; *f.* lysis failures.

STAPEDOLYSIS SURGICAL DETAILS

Name of patient ________ Case No. ____
Date of surgery ________ Age __ Sex __ Ear ____

I. EXTERNAL EAR
A. AURICLE ____ C. CANAL SHAPE & DETAILS ____
B. SKIN ____ D. EXOSTOSES ____

II. MT
A. RETRACTION ____ C. CALC PLAQUES ____ E. ATROPHIC ____
B. SCARS ____ D. HEALED PERFORATIONS ____

III. TYMPANUM
A. EXPOSURE ____ D. PS ANNULAR QUADRANT ____
B. CHORDA TYMPANI ____ E. PROMONTORY ____ G. ROUND WINDOW ____
C. I DETAILS ____ F. S DETAILS ____ H. TENDON DETAILS ____

IV. LYSIS STEPS ________
I-S DISLOCATION ____ CRURAL FRACTURE ____
FOOTPLATE BLEEDING ____ DIRECT FOOT PLATE LYSIS ____

V. SUBJECTIVE PHENOMENA
PAIN ____ TINNITUS ____ VERTIGO ____
TONGUE ____ BLOCK REMOVAL ____ HEARING ____

VI. CLOSURE
PERFORATION ____ NYSTAGMUS ____

VII. MISCELLANEOUS

Fig. 10. Data recording sheet during stapedolysis surgery.

Trans-tympanic exposure problems occurred in 40 per cent of all cases. In all of these, bone removal by curette, burr, or

both, was necessary in the postero-superior annular quadrant. In this group of cases no significant trends toward success or failure could be found.

Hemorrhage from the incision was encountered in 60 per cent of all cases; nevertheless, this factor did not appear to be significant in producing success or failure.

Tympanic perforations occurred in 17 per cent of all cases. Most were tiny tears, and all were immediately closed with a small skin graft as previously described. (Only two persistent perforations are present in this entire group.) In this group there was no deviation from the previous result averages.

Incudo-stapedial dislocation occurred temporarily in 9 per cent and probably permanently in 10 per cent. Here, probably because of the small number of cases, no significant trends were found.

Crural injuries were observed in 14 per cent ranging from partial to complete fractures. Here again, no significant departures from the previous data were found.

In 10 per cent of the cases which were adequately lysed or mobilized, according to surgical audiometric nomographs, postoperative success did not occur. In the absence of significant operative deviations it must be concluded that these represented rather *immediate re-ankyloses*. This group is, of course, classified above under failures.

In the final analysis, except for the 10 per cent of immediate re-ankyloses, it seems that *simple lysis failure* is the main cause of "immediate operative failures". Review of operative nomographs shows a high degree of correlation of nomographic failures and failure to mobilize.

D.—RE-ANKYLOSIS.

Evidence of late partial or complete re-ankylosis of the footplate with threshold losses in primary successful cases has been found in 11 cases in this series of 200; however, this is undoubtedly a low figure and a premature survey, since the

series of 200 cases extends from November, 1954, to December, 1955. The ultimate ratio of incidence of re-ankylosis is an exceedingly important figure in any analysis of this surgical approach.

As Rosen[6] pointed out, one wonders why all of the successful cases do not re-ankylose; yet, in the few reports so far, very few have been reported. It is possible that capsular bone, especially pathological capsular bone, does not have good regenerative powers; neverthelss, the fact that, in little over a year, 11 cases have shown significant threshold losses, is cause for serious study.

A preliminary survey of these 11 cases shows partial re-ankylosis in six and probably complete re-ankylosis in five cases, as determined by audiometric studies. No special differences as to age or sex are apparent. Duration of disease prior to surgery does not appear to be a significant factor. One very important fact is that of this group of 11 cases, only one patient had preoperative bone conduction better than 20 db. The rest were definitely poor candidates with preoperative bone conduction levels ranging from 35 db to 55 db. Surgical re-exploration is planned for most of these cases, prior to fenestration. None has been explored yet.

E.—STAPEDOLYSIS REVISION OF STAPEDOLYSIS FAILURES.

Three cases in which stapedolysis attempts were primary failures were revised by the stapedolysis technique. In two cases, lysis was obtained with improvement in hearing, probably due to more effective application of force in a previously partly mobilized footplate. In the third case, failure to mobilize again was experienced.

F.—FENESTRATION OF STAPEDOLYSIS FAILURES.

Three fenestration operations have been performed by the author in stapedolysis failures. Excellent primary postoperative results have been obtained in all three. Long term observations are unavailable, of course, at this early writing.

No special surgical problems were encountered in these cases. The preparation of the tympanomeatal membrane was unusually easy, probably due to previous elevation in stapedolysis. It should be noted that the stapedolysis incision of the author is intentionally generous, in order to avoid a scar in the region of the thin portion of the membrane which would be used to cover the fenestra.

G.—STAPEDOLYSIS REVISION OF PREVIOUS FENESTRATION FAILURES.

Prompted by the Rosen[6] case report in which he successfully mobilized the stapes in a post fenestration closure, the author attempted this procedure in five cases. In none of these cases was a hearing gain obtained, even though visual evidence of mobilization appeared probable in at least four of these cases.

It is possible that this problem may yet lend itself to solution. If the footplate ankylosis can be adequately lysed, hearing gains should be possible if a successful myringo-stapediopexy could be obtained. Under other circumstances, hearing gains might be obtained through a phase reversal phenomenon, by a permanent tympanic perforation, in which the round window would become the entrance route of air-borne sound to the perilymph space.

H.—BINAURAL STAPEDOLYSIS.

In the 200 ears reported above, 34 represented the second ear in as many patients (total 68 ears). In seven of these patients (14 ears) stapedolysis failures were encountered binaurally. In 11 cases (22 ears) successes were obtained binaurally. In 16 cases (32 ears) successful results were obtained on one ear (16), even though failures were obtained on the other ear (16).

I.—EXAMPLES OF SUCCESSFUL AND UNSUCCESSFUL RESULTS.

Specific examples of both successful and unsuccessful cases may be of interest.

1. Case No. 171 (see Fig. 11).

51-year-old female. This patient with poor bone conduction has been restored to unaided hearing.

Case No. 171

	DATE	500	1000	2000	4000			SRT	SDT
PREOP. BONE	11-7-55	40	40	45	40			40	
PREOP. AIR		60	70	90	70			65	60db
SURGERY									
Drum in place #1	11-8-55	65	75	80				70	
Drum open #2		55	70	70				62½	
Drum open-stapes mobile #3		40	50	45				42½	
Drum in place stapes mobile #4		30	40	40				35	
POSTOP. Air	12-7-55	20	35	40	40			30	

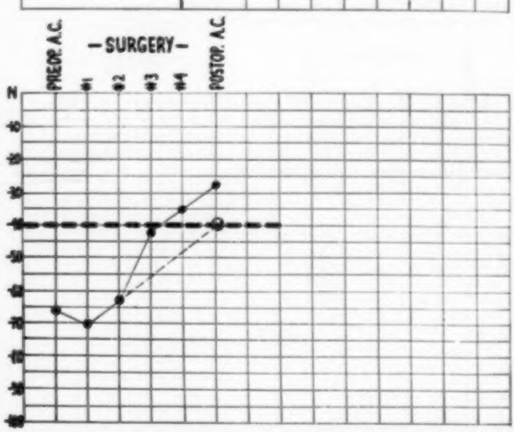
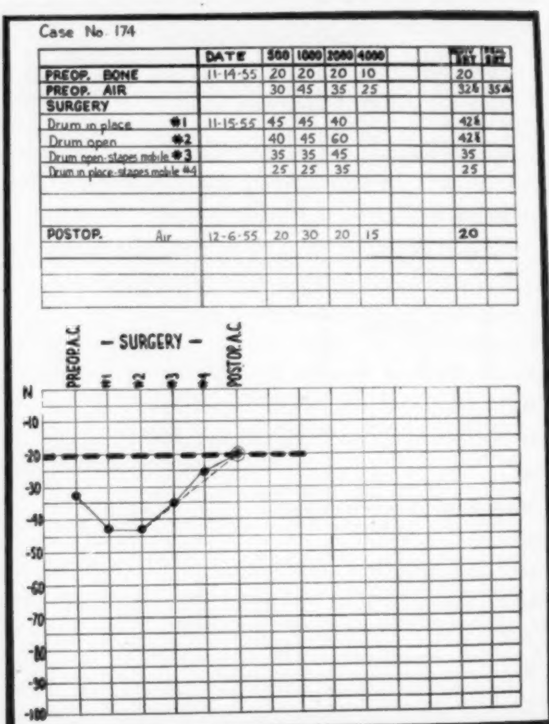


Fig. 11.

2. Case No. 174 (see Fig. 12).

33-year-old female. This patient with good bone conduction has reached her bone conduction level.



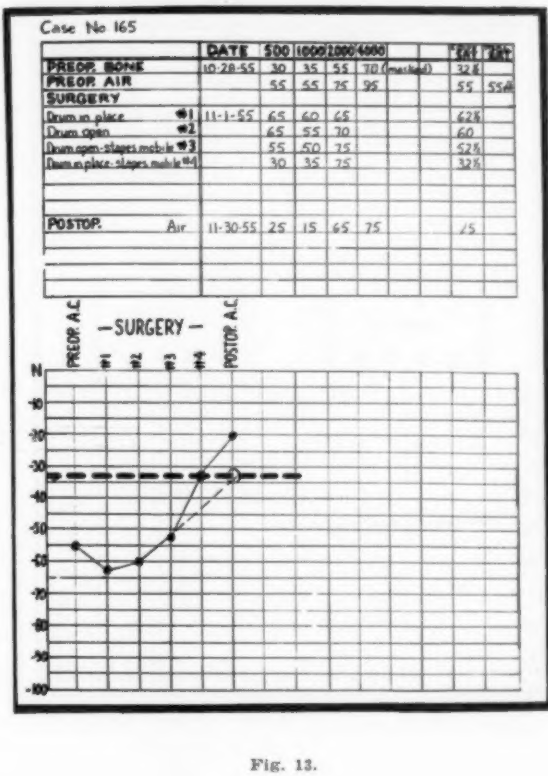
Case No. 174

	DATE	500	1000	2000	4000			[illegible]	[illegible]
PREOP. BONE	11-14-55	20	20	20	10			20	
PREOP. AIR		30	45	35	25			32[illegible]	35A
SURGERY									
Drum in place #1	11-15-55	45	45	40				42[illegible]	
Drum open #2		40	45	60				42[illegible]	
Drum open-stapes mobile #3		35	35	45				35	
Drum in place-stapes mobile #4		25	25	35				25	
POSTOP. Air	12-6-55	20	30	20	15			20	

Fig. 12.

3. Case No. 165 (see Fig. 13).

53-year-old male. This patient with marked high tone deficit by B.C. and A.C. nevertheless improved to a level better than preoperative B.C. in the lower frequencies, and was restored to unaided hearing.



	DATE	500	1000	2000	4000			[illegible]	[illegible]
PREOP. BONE	10-28-55	30	35	55	70 (masked)			32½	
PREOP. AIR		55	55	75	95			55	55[illegible]
SURGERY									
Drum in place #1	11-1-55	65	60	65				62½	
Drum open #2		65	55	70				60	
Drum open-stapes mobile #3		55	50	75				52½	
Drum in place-stapes mobile #4		30	35	75				32½	
POSTOP. Air	11-30-55	25	15	65	75			25	

Fig. 13.

4. Case No. 178 (see Fig. 14).

60-year-old female. This patient with preoperative B.C. averaging 47.5 db reached a postoperative A.C. level of 20 db.

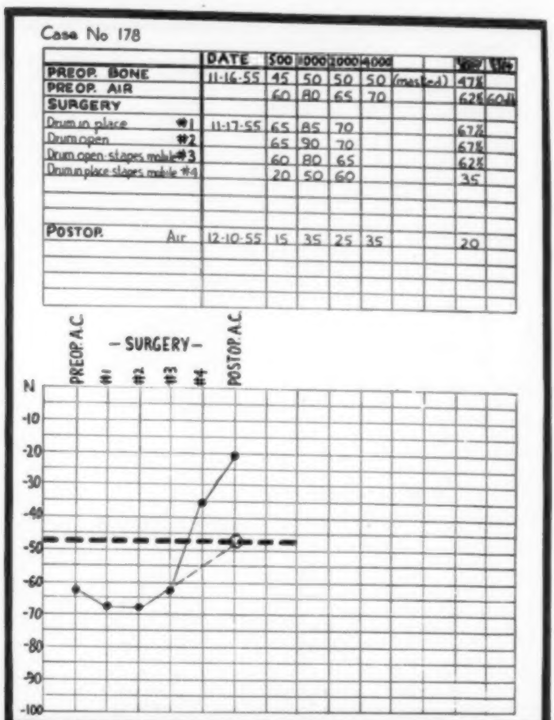


Fig. 14.

5. Case No. 163 (see Fig. 15).

31-year-old female. This patient with excellent preoperative B.C., and a good fenestration candidate, nevertheless failed to reach a satisfactory level.

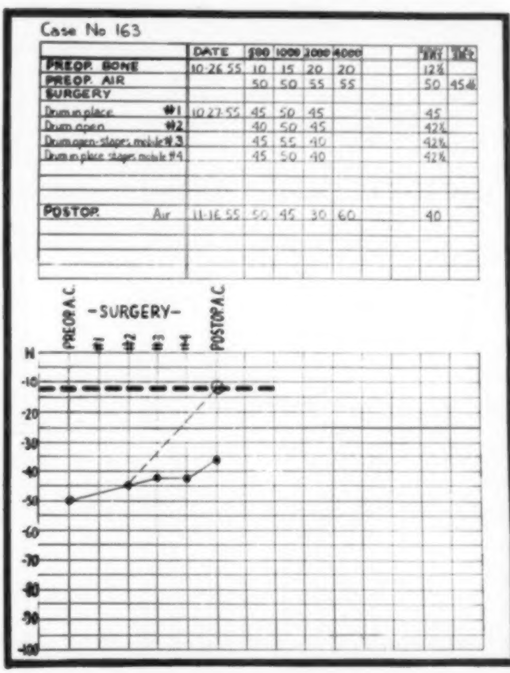


Fig. 15.

6. Case No. 156 (see Fig. 16).

24-year-old male. This patient with excellent preoperative B.C. failed to reach a satisfactory level.

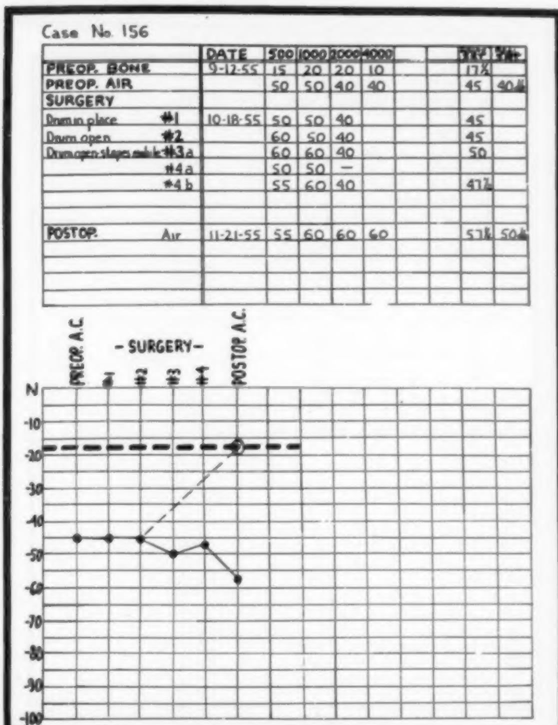


Fig. 16.

7. Case No. 141 (see Fig. 17).

59-year-old female. This patient with poor preoperative B.C. nevertheless showed excellent nomographic surgical progress; however, her two-week postoperative threshold fell below expectations, and an eight-week postoperative threshold showed complete re-ankylosis.

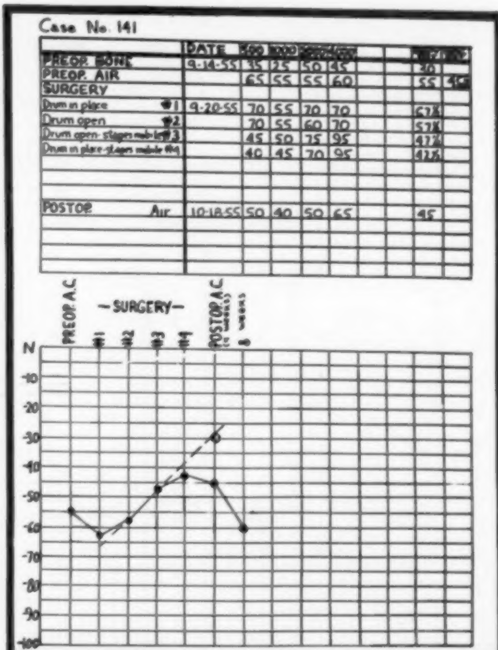


Fig. 17.

8. Case No. 129 (see Fig. 18).

55-year-old male. This patient with poor preoperative B.C. showed excellent nomographic progression surgically. Unusual hemorrhage complicated the procedure with marked early postoperative regression; nevertheless, slow recovery occurred with subsidence of the hemotympanum, and 18 weeks postoperatively the preoperative B.C. level was reached. A gain of 35 db.

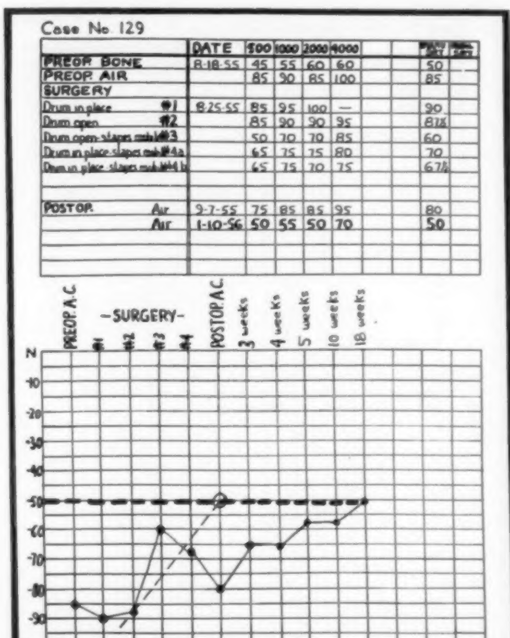
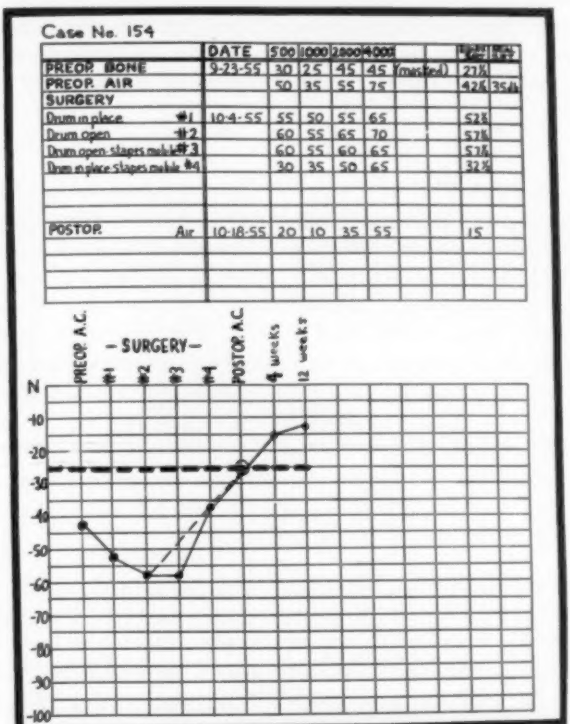


Fig. 18.

9. Case No. 154 (see Fig. 19).

28-year-old male. This case was characterized by temporary incudo-stapedial dislocation. Repositioning of the bones was successful, and subsequent nomographic course shows an excellent result.



Case No. 154

	DATE	500	1000	2000	4000			[illegible]	[illegible]
PREOP. BONE	9-23-55	30	25	45	45	(masked)		27%	
PREOP. AIR		50	35	55	75			42%	35db
SURGERY									
Drum in place #1	10-4-55	55	50	55	65			52%	
Drum open #2		60	55	65	70			57%	
Drum open-stapes mobile #3		60	55	60	65			57%	
Drum in place stapes mobile #4		30	35	50	65			32%	
POSTOP. Air	10-18-55	20	10	35	55			15	

Fig. 19.

Thus it can be readily seen that there are many apparent inconsistencies in these results and much study is necessary for modifications in technique.

J.—TINNITUS.

An evaluation of tinnitus is in progress at the present. To date, it seems that tinnitus has been relieved in most successful cases and unchanged in failures. There are exceptions, however. Several successful cases audiometrically, report increased tinnitus. Several failures report tinnitus disappearance. Several failures report tinnitus increases.

VI. CANDIDATE SELECTION TRENDS.

So far no method of real value has been devised for the selection of candidates in stapedolysis. A number of possible criteria have been considered in the approach to a selection formula; namely *1.* preoperative bone conduction; *2.* preoperative air conduction; *3.* preoperative air-bone gap; *4.* age of candidate; and *5.* duration of disease. Duration of disease, the last item listed, has not been studied in this series because of difficulty in obtaining meaningful figures from the average patient. It is not too difficult to determine the age at which the deafness became a social and economic problem, but it is very difficult to determine the actual onset of hearing deterioration. Consequently, this factor has not been evaluated seriously in our study at the present time.

Bone conduction has been the base for the selection of fenestration candidates, and thus there has been some tendency to continue selection by the same formula in stapedolysis. We have already examined the influence of various bone conduction levels, and the probability of success, in Fig. 6-C, and found that if we limit our consideration to those groups of the 189 total that provide over ten samples (–10 to –40 db) we do not find a decisive trend toward success or failure over this area. Too few cases are involved at levels above –10 or below –40 db to consider the rise shown at both ends of the median line as typical. Thus from the data at hand, bone con-

duction alone does not seem to contain preoperative information of value in candidate selection for stapedolysis.

Air conduction levels would seem logical as one approach to the degree of fixation, and this factor is explored in Fig. 20. Preoperative distribution of air conduction levels, for the 189 cases as shown in Fig. 20-A. In Fig. 20-B, the percentages of success and failure are treated as in Fig. 6-C, to obtain the same type of graph. The median line displays a very slight downward trend with increased air conduction loss; however, there is nothing here that would be sufficiently significant to set up rigid selection criteria.

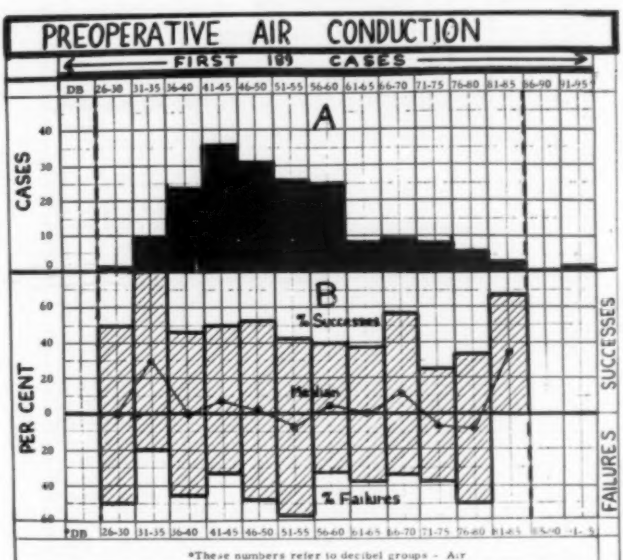


Fig. 20. Preoperative air conduction levels in 189 consecutive cases.

A—Distribution of air conduction levels. The extreme case shown at 91-95 db made a significant gain but was not a success.

B—Percentage of successes in each 5 db group is plotted below the same line. The "median" line derived from both appears to be essentially random in character, where the number of samples are significant.

The question of bone-air gap as a method of exploring selection criteria is studied in Fig. 21. The distribution of the bone-air gap is shown in Fig. 21-A, while the percentage of successes and failures are plotted as before in Fig. 21-B. Here, again, there is no decisive swing in the median line, and this factor cannot be advocated at the present time as a significant technique in selection of candidates.

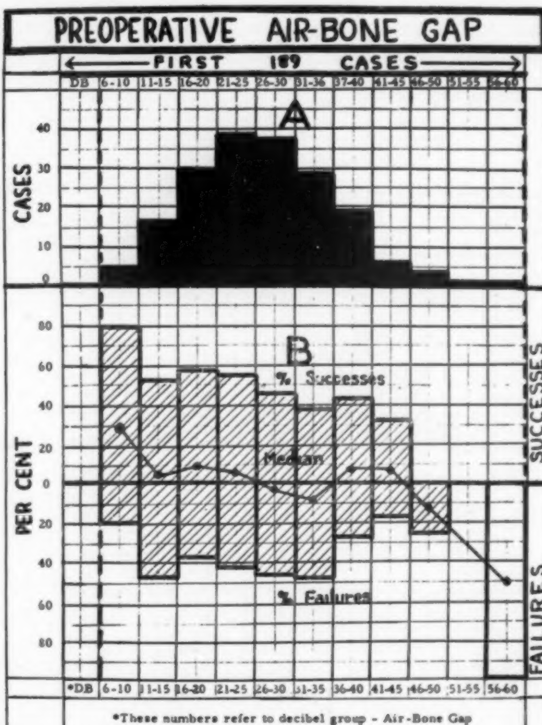


Fig. 21. Preoperative air-bone gap in 189 consecutive cases.

A—Shows the distribution of the differences between air and bone conduction before surgery.

B—Shows the per cent of successes in each 5 db group plotted above zero, and the failures in the same groups plotted below the zero line. Between minus 10 and minus 40 db the "median" line is nearly random in excursion.

The factor of age of candidate appeared to be a reasonable one in the question of selection for stapedolysis, and this factor is studied in Fig. 22. Fig. 22-A shows the percentage relation of success and failure as in previous graphs. There seems to be a trend showing a probability of greater success in the early 30 group and in the late 50 group, with a somewhat declining median line in the 40 to 50 age group; however, these trends are only of interest, and not significant enough to warrant our using them in candidate selection at the present time.

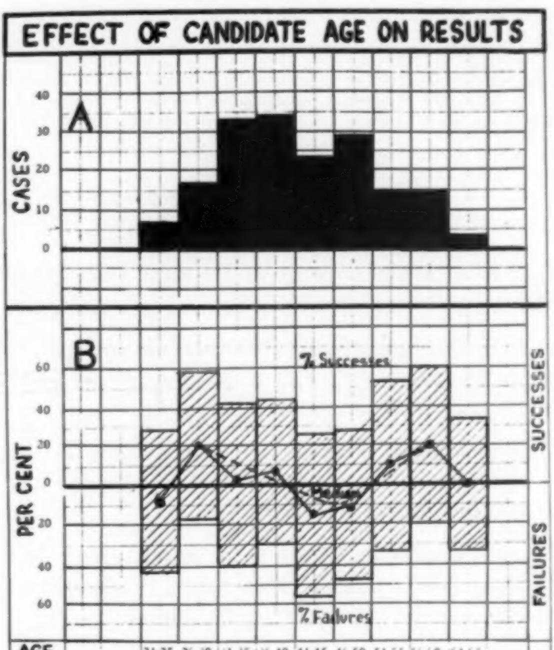


Fig. 22. Effect of candidate age on results.

A—Distribution of age in 176 candidates. Information on age was lacking in 13 of the 189 cases.

B—The median line in this case appears to display a definite characteristic. The 26 to 30 and 56 to 60 year groups appear most favored. The 40 to 50 year groups show least probability of success.

VII. SUMMARY.

1. The primary direct surgical approach to the oval window has been revived in the treatment of otosclerosis.

2. Early reports of results in this renaissance of stapes mobilization (stapedolysis) surgery are encouraging.

3. Stapedolysis, a direct approach with no physiological deficit, has a wider application than fenestration in otosclerotic patients.

4. Successful results in stapedolysis are defined in two ways: *a.* achievement of 30 db level and *b.* eradication of bone-air gap.

5. Stapedolysis is an approach requiring varying techniques to cope with pathologic variations.

6. Precise microsurgical technique controlled by surgical audiometry is necessary in stapedolysis.

7. Operative and postoperative problems and complications have been analyzed in over 200 cases.

8. A significant number of successful results have been observed for periods of six to 12 months, as stable gains. Further long range observation is essential.

9. This technically complex and delicate surgical approach is, nevertheless, benign for the patient; it is quite free of operative and postoperative dangers.

10. In the evaluation of the most recent group of 89 consecutive cases (of a total of 189 cases), results show 56 per cent successes and 11 per cent partial gains.

11. These encouraging results seem to indicate that stapedolysis is a justifiable first choice in the surgical treatment of otosclerosis. In the event of failure, recourse to a successful fenestration is still possible.

12. This revival of stapedolysis will call for vigilant objectivity in long range appraisal.

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A STUDY OF THE ROLE OF CERTAIN FACTORS IN THE DEVELOPMENT OF SPEECH AFTER LARYNGECTOMY: 1. TYPE OF OPERATION; 2. SITE OF PSEUDOGLOTTIS; 3. COORDINATION OF SPEECH WITH RESPIRATION.†

Part 2: Site of Pseudoglottis.†

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Interest in discovering the site or source of vibration in substitute voice production has led to speculation and investigation from the time that cases of substitute voice were first reported. No definite site has been generally agreed upon, however, partly because of the unique difficulties encountered in efforts to study a pseudoglottis in action.

The value of objective evidence in demonstrating the location of the pseudoglottis is apparent. Not only is such evi-

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† This paper, presented in three parts, is based on the research associated with " A Study of the Role of Three Factors in the Development of Speech after Laryngectomy: Type of Operation, Site of Pseudoglottis, and Coordination of Speech with Respiration," an unpublished Ph.D. dissertation (Northwestern University, 1954) by Evelyn Y. Robe. Part 1 appeared in the March, 1956, issue of The Laryngoscope, and the May, 1956, issue will carry Part 3.

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dence important to surgeons who hold the opinion that every effort should be made to preserve the structures involved, but it would also unquestionably influence terminology and teaching procedures.

Gross classifications of substitute voice, such as the following, imply that the pseudoglottis is to be found in the general anatomical area named; however, a more accurate anatomical localization in some types of substitute voice seems desirable.

The Buccal Voice. This form must be distinguished from the "buccal whisper" produced without a pseudoglottis, which is almost completely inaudible and, therefore, considered generally undesirable. The true buccal voice is audible, its sound being produced by a pseudoglottis within the buccal cavity. In one type, an air bubble is formed between the cheek and maxillary arch. Muscular action drives the air through a narrow opening between or behind the teeth into the wider cavity of the mouth where the sound is articulated into speech.[23]

The Gastric Voice. According to Kallen, "in gastric voice the gastric air bubble functions to produce vicarious speech", frequently giving the auditory impression of "belly clang". The sound made by eructation from the stomach, combined with articulation, may be enough to eliminate the need for a pseudoglottis as a specifically developed structure in many laryngectomized speakers.

The Pharyngeal Voice. In this voice, the sound producing mechanism lies in the mesopharynx or hypopharynx.[10]

The Esophageal Voice. Sound for this voice is produced by a pseudoglottis formed at the upper end of the esophagus at the level of the cricopharyngeus muscle. The air reservoir is within the lumen of the esophagus and the cardiac end of the stomach.[10]

The possibility that transition from one type of pseudovoice to another may occur has been discussed by Kallen. When first learning to speak, the beginner overdoes the process of taking in air, a large supply accumulating in the stomach and lower esophagus. As he continues to practice, however, the air is converted into sound more quickly, the path becoming

ever shorter, until the air is transformed automatically into sound with the swallowing.[18]

While "esophageal voice" is the term most frequently used to describe substitute voice, usually without particular reference to the site of pseudoglottis, some investigators prefer a less specific term, such as "substitute voice". Kallen recommends the following:

"Since the mechanism of speech varies so greatly in laryngectomized subjects, a term is preferred which designates all the facts. Although *pseudovoice* does so for voice, it is inapplicable to the pseudowhisper. I propose, therefore, the term alaryngeal speech, which means speech without a larynx, regardless of the mechanism involved, and which logically includes the pseudowhisper."[10]

As mentioned earlier, efforts to study the site of the pseudoglottis invariably meet with great difficulty and lead to results which are generally inconclusive. When mirror examination of the lower pharynx was attempted, for example, movements of gagging and the presence of secretions often obscured the vibrating structures. Protrusion of the tongue for viewing the hypopharynx ordinarily modifies or eliminates posterior glossal vibration, although in some cases inspection of the area during sound production is possible without tongue protrusion. Froeschels cautions that even when the back of the tongue is retracted toward the pharyngeal wall or the narrow pillars of fauces appear to be vibrating, there is still the possibility that the real pseudoglottis is located at a lower level. He adds that "even if stroboscopy reveals vibrations of the pillars or of the tensed velum palatini, it still cannot be decided whether or not these vibrations are transferred by air originally brought into vibration at the entrance of the esophagus."[3] With regard to other methods of study, Kallen suggests:

"Palpation also is an aid in differentiating areas of vibration. And although the roentgen rays are not useful here as in the study of the vicarious air chamber, they occasionally enable one to make certain inferences. In general, however, the membranous folds and the muscular bulgings involved are too slight to be distinguishable from surrounding tissue. The findings in a few patients who had come to necropsy because of

recurrence have not helped much in indicating how the vicarious glottis developed and acted."[10]

Various anatomic structures which may serve as a pseudoglottis have been reported in the literature. Stern thought it could be formed in any one of the following places: *1.* between the base of the tongue and the posterior wall of the pharynx; *2.* between the back of the tongue and the tightly stretched velum; *3.* between strongly contracted posterior arches of the two sides; *4.* between contracted portions of the inferior constrictor; *5.* between the epiglottis and the two folds formed laterally from the musculature of the pharynx; *6.* the esophageal mouth of Killian, between the folds of the cricopharyngeus; *7.* no real glottis, in some, rather the sound of eructated air.[17] Kallen lists the same structures, except the last. He adds that "every fold of mucous membrane, every favorably placed cicatricial band, every muscle or muscular remnant, may serve as the basis for the development of a pseudoglottis."[10]

Jackson and Jackson report that the tissues they have observed in vibration include:

"*1.* The pillars of the fauces under muscular action; *2.* the tongue against the back wall of the pharynx; *3.* the tongue against the posterior pharyngeal wall; *4.* the remnant of the tip of the epiglottis against the back wall of the pharynx; *5.* adventitious folds in the hypopharynx; *6.* the anterior wall of the hypopharynx coming against the posterior wall; *7.* a pseudosyrinx formed in the esophagus by the collapse of one wall against the other with the axis of the chink noted in some cases in the frontal plane, in others in the sagittal plane, and in still others in one of the diagonal planes; *8.* a cicatricial band against the normal tissue; *9.* a pair of cicatricial bands; *10.* secretions forming bubbles aiding the tissues."[9]

Levin thinks that the pseudoglottis varies in the individual patient, depending upon the type of operation performed and the remaining tissues. The structures which may function as vibrators are:

"*1.* the epiglottis tip, if this is permitted to remain; *2.* the pillars of fauces; *3.* the tongue against the posterior wall;

4. the collapsing esophageal wall against the opposite side; *5.* a cicatricial band against the normal tissue; *6.* others which cannot be identified by present knowledge."[11]

Mason also describes these structures as possible sites of the pseudoglottis, but adds that "more often, no definite pseudoglottis can be demonstrated even though the voice may be perfectly satisfactory."[14]

A considerable number of investigators are of the opinion that the mouth of the esophagus, or cricopharyngeus, forms the most efficient pseudoglottis for the laryngectomized speaker. Included in this group are: Kallen,[10] Stetson,[22] Gatewood,[6] Howie,[8] McCall and Stover,[15] Greene,[7] Martin,[13] Levin,[11] Lindsay, Morgan and Wepman,[12] Mason,[14] Moolenaar-Bijl,[16] Pancoast, Pendergrass and Schaeffer,[20] Gardner,[4] Negus,[19] and Brighton and Boone.[2]

Kallen reported that as early as 1888, Bandler described a case in which the cricopharyngeus functioned as the pseudoglottis in producing a substitute voice. In the same article reference was made also to Fraenkel in 1893, who published an account of a similar case which had been corroborated by Gutzmann.[10]

Seeman made one of the first scientific studies of the problem, using the method of Roentgen examination. Morrison reported Seeman's conclusions to the effect that the anatomic and physiologic conditions of the esophagus meet the requirements for the production of substitute voice in every respect. He described contractions of the esophageal mouth during phonation and expressed the opinion that the striated muscles involved could function under partial voluntary control. The esophagus formed an ideal air chamber, he thought, because of its capacity to: *1.* hold more than a few cubic centimeters of air; *2.* be filled with air quickly and voluntarily; *3.* expel air under control; and *4.* set the pseudoglottis into vibration by providing the necessary air current thus fulfilling the requirement that the air chamber be caudal to the pseudoglottis.[17]

Morrison and Fineman described the pseudoglottis formed at the cricopharyngeus and its advantages in the following way:

"True esophageal voice is characterized by the fact that the pseudoglottis lies at the level of the cricopharyngeus muscle, and the air reservoir is within the lumen of the esophagus and the cardiac end of the stomach. . . . When it has been learned and practiced long enough it is produced with little effort, is loud and clear enough for all ordinary conversation and carries very well by telephone."[18]

The majority of those who regard the cricopharyngeus as the most frequent site of the pseudoglottis base their conclusions, at least in part, on Roentgenological observations, which despite many limitations, have provided the most objective visual evidence thus far.

The studies of Brighton and Boone in 1937, Pancoast, Pendergrass and Schaeffer in 1940 and Lindsay, Morgan and Wepman in 1944, were specifically devoted to Roentgenologic and fluoroscopic examination of the substitute speech mechanism in laryngectomized persons.

Brighton and Boone reported that their films showed the site of vibration or pseudoglottis as corresponding to the anatomical position of the cricopharyngeus muscle; moreover, they stated that "the action of the pseudoglottis is similar to that of a normal glottis, the vibrating membrane of the tracheobronchial tree of certain lower animals or the reed of an artificial larynx".[2]

Pancoast, Pendergrass and Schaeffer observed that:

"As the patient begins to talk, certain muscles appear to contract and reduce the shadow of the pharyngeal air space. In this stage it is possible to see a soft-tissue shadow, which more or less completely separates the air-space of the pharyngoesophageal reservoir from that of the remainder of the esophagus. We have felt that this shadow is produced by a compensatory development of the cricopharyngeus muscle."

Lindsay, Morgan and Wepman discovered in the course of their investigation that:

"During phonation it can be seen that the sphincter is not completely closed, leaving a small channel for air to escape. Although the pitch of the sound produced is very low, it is not

possible to detect vibratory movement of the muscular fold under the fluoroscope; however, with an exposure which varies from one-twentieth to one-thirtieth of a second, the Roentgenograms taken during phonation regularly show distinct blurring of the edges of the fold, while those made during resting stage or modified Valsalva test show clear-cut borders and a completely closed sphincter. It appears clear, therefore, that the movement set up in the borders of the muscular fold by the column of air escaping through the spincter constitutes the mechanism of sound production."[12]

They concluded from their data that "the proficiency of the esophageal voice is related to the degree of control over the cricopharyngeus muscle".[12]

One of the most recent investigations of the subject based almost entirely on fluoroscopic and Roentgenographic data is that of Pellegrini and Ragaglini, in 1951. Their observations were made on laryngectomized patients, before and after speech training. In contrast to the majority of investigators, they refute the idea that a pseudoglottis actually forms in the speaker. They conclude that a squeezing mechanism apparently forces air to pass through a narrow channel, thus producing sound.[21] No explanation is given as to why the narrow channel should not be considered the pseudoglottis.

While fluoroscopic and Roentgenological studies have provided the most objective data thus far, the need for further research in this area, employing new or different techniques is evident. In the study being reported here motion picture photography and Roentgenography were the procedures used to obtain visual evidence of the location of the pseudoglottis and its air supply.

Twenty laryngectomized speakers who exemplified variations in the manner of producing voice (*e. g.*, lip and swallowing movements), as well as differences in pitch, were selected as subjects. A thorough examination of the pharynx and hypopharynx of each subject was made with a conventional laryngeal mirror in order to observe size, shape and functioning and to note the presence or absence of structures such as tonsils and epiglottis. Each operative report had previously been reviewed to learn what muscles or structures remained which

might function in the production of sound. The subject was then asked to produce the vowel "eh": first, in his usual manner; and again with the tongue forward and the mirror adjusted in the pharyngeal area to reflect vibratory movement there or below.

When the examination indicated that the individual would be a satisfactory subject, or that with training he might become one, he was given equipment and instructions for practice at home. The equipment consisted of a No. 3 laryngeal mirror and two stationary mirrors (one a concave head mirror), mounted on a ring stand. Directions were given for the location of the light to be reflected from the concave mirror into the pharynx, the adjustment of the guttural mirror, and for checking the procedure in the second stationary mirror. After adequate practice at home and in the laboratory, the subject was considered ready for photography.

The procedure followed was the same as for laryngeal photography.[1] The subject was instructed to produce the vowel "eh", sustaining it as long as possible or continuing to repeat it while the camera was in operation. Magnetic tape recordings of the sounds produced were made concurrently with the films.

Analysis of the films consisted essentially of location of the sound source and descriptions of the individual pharyngeal variations.

Original plans included the use of high-speed photography, but technical difficulties made it impossible to carry out this procedure. The laryngectomized patients were not able to devote the time necessary to learn to produce voice upon a given signal, with the pharyngeal mirror in position and within the brief time of the filming.

X-ray Data: Sixteen laryngectomized speakers served as subjects for the Roentgenography. For visualization, a mixture of barium and butter was made, as described by Hoerr[5] and was spread thickly on a large soda cracker. This combination adhered to the mucosal surfaces a sufficient length of time to permit good Roentgenograms. Half the cracker was consumed before the first two films; the remainder before the others.

Film 1 was made with the subject at rest, prior to air intake for speech; Film 2 showed the structures just after the subject had taken in a maximum amount of air in preparation for phonation. Film 3 was exposed during production of the vowel "ah" and Film 4 followed immediately after the production of the vowel.

Photo. 1. Photo. 2.

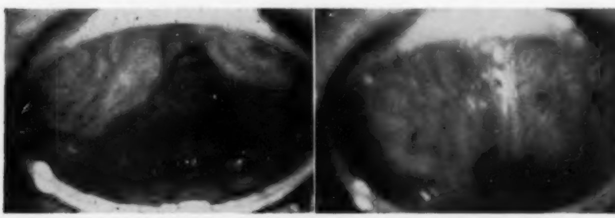

Photo. 3. Photo. 4.

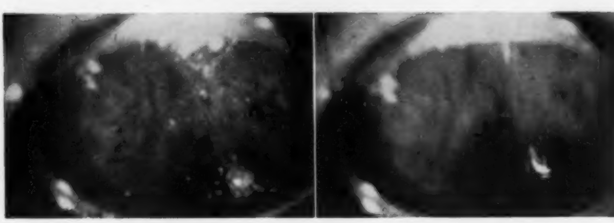

Fig. 1. Photographs 1, 2, 3, 4. Enlargements of representative 16 mm. motion picture frames showing sphincter-like constriction and relaxation of the pharyngeal walls during bucco-esophageal phonation.

The subject's position was changed for the fifth film so that he stood at a 45-degree angle to the chest table. This provided a full length view of the esophagus. The instructions given were the same as for Film 2 and the exposure was made when the subject had taken in the amount of air preparatory to phonation.

Areas of constrictor action, changes in contours, or other evidence of pseudoglottis formation were studied, and locations in relations to vertebrae were noted. Visible changes in the air column in the pharynx and esophagus preceding phonation, and presence or absence of an air column below the pseudo-

glottis when phonation was initiated and immediately afterwards were also noted.

Films 14 x 17 inches, which showed an increased length of esophagus, were studied separately to discover whether the change in the subject's position might bring into prominence structures or evidence of function which were not visible in the lateral view.

Fig. 2. Subject XI, Film No. 1. Air column observed in esophagus preceding phonation.

A study of the motion picture films, the associated sound recordings and the X-ray photographs pointed up certain problems and provided a few conclusions.

Motion Picture Data. Only eight of the 20 subjects originally selected for photography finally proved to be suitable. The major difficulties were: some could not phonate with the

mouth wide open, others could not tolerate a mirror, while still others were unable to produce sound with a mirror in place.

In the analysis of the films, the pattern of movement most frequently observed was that of a circular drawing together of the walls of the pharynx, and a marked bubbling of saliva as the sound was produced, followed by a drawing apart of

Fig. 3. Subject XI. Film No. 2. Air column following maximum oral intake of air preparatory to sound production.

the pharyngeal walls. These adjustments are illustrated in Fig. 1 by selected frames from a film sequence. In Photograph 1, the irregular mass occupying the upper third of the image is the base of the tongue. The dark area just above the lower part of the mirror rim represents the posterior pharyngeal wall which drops almost vertically. Photographs 2 and 3 show a rapid backward sweep of the tongue combined with the

radial movements of the lateral pharyngeal walls in a sphincter-like closure. The bright spot in the lower section of Photograph 3 pictures a bubbling of mucous and saliva produced by the expulsion of air from below it. It is probable that some of the sound is produced by this bubbling action. Photograph 4 shows the tongue and pharyngeal walls returning to the position of rest shown in the first photograph.

Fig. 4. Subject XI, Film No. 3. Constriction of the esophageal air column during production of vowel sound "ah."

The photographs of Fig. 1 show a type of closure which involves the tongue and which is made relatively high in the pharynx. The closure in most of the subjects was lower in the pharynx, but these photographs were used because they gave a clearer representation of the movements.

The eight individuals participating in this procedure were excellent speakers. Their films indicate that in every case, with

the possible exception of one, the pattern of movement as described above takes place at the level of the cricopharyngeus. This evidence, although from a limited number of subjects, lends further support to the observations of those using other methods to determine the site of the pseudoglottis, that the region of the cricopharyngeus is the usual location.

Fig. 5. Subject XI, Film No. 4. Constriction still apparent following phonation; air column below decreased in size.

Perhaps the chief value of the results of the pharyngeal photography is that the films demonstrate that clear, permanent, visual records of the changes taking place in the mouth, pharynx, and upper esophagus during production of substitute voice are possible.

X-ray Data: An air column was observed in the pharynx and esophagus of 15 of the 16 subjects preceding phonation

(see Fig. 2, Subject II, Film 1). An increase in the size of the air column was noted in 11 instances, following maximum oral intake of air preparatory to sound production (see Fig. 3, Subject II, Film 2). During the production of the sustained vowel "ah" in Film 3, definite constrictions of the esophageal air column were visible in the films of 13 of the subjects. In

Fig. 6. Subject XV, Film No. 1. Beginning of phonation of poor speaker. Note absence of air column in cervical esophagus.

seven of the 13, the constrictions appeared in the area of the esophagus opposite vertebrae 5 and 6. In three, it was opposite vertebra 7. In one case, it was opposite the third vertebra, and in two cases, a double constriction was noted.

The appearance of such constrictions, particularly in the region of the fifth and sixth vertebrae, bears out the findings of other investigators who have used the Roentgenological

method. The present X-ray films also tend to confirm Hoerr's[5] observation that the laryngectomized speakers with the best voices have the sharpest constrictions in the area of the crico-pharyngeus.

In most subjects the constriction was still apparent following phonation, but the air column below had decreased in size (see Fig. 5, Subject XI, Film 4). In some cases, the column above the constriction had grown larger.

Fig. 7. Subject XV, Film No. 2. Second stage of phonation of poor speaker. Tongue is raised, pharynx narrowed.

One of the most significant observations provided by the X-ray series relates to the presence or absence of an air column below the constriction as described for Subject XI, Film 3 (see Fig 4). In the 14 good speakers, a sizable air column

was demonstrated below the area of constriction or pseudoglottis. In the two poor speakers, one whose X-rays are shown, this air column was not demonstrated, Subject XV (see Figs. 6, 7, 8, 9). It appears that an adequate sized air column is extremely important.

The lateral view X-ray films of the two subjects demonstrate the difference which is visible when an air column is present and when it is not. Subject XI is a speaker with an

Fig. 8. Subject XV. Film No. 3. Mouth open, pharynx constricted, esophageal column compressed from below.

excellent substitute voice of more than adequate volume, while Subject XV is a poor speaker who lacks control of the air used for sound, and whose voice is frequently too weak to be heard. It should be noted that in Subject XI the hyoid bone has been

left in place; in subject XV the hyoid bone has been removed. Of the remaining speakers, those possessing superior voices generally revealed a larger air column below the constriction during phonation (see Fig. 4) than that which appeared above. The presence or absence of the hyoid bone was not related to quality of voice in the other subjects.

Fig. 9. Subject XV, Film No. 4. Completion of phonation of "ah." Mouth closed, pharynx returning to resting position, esophageal column returning to original straight course.

The single 14x17 inch oblique chest view X-ray films yielded little information beyond the observation that with the exception of two subjects, who were very poor speakers, air was visible throughout the length of the esophagus rather than in the upper part alone.

In summary, it appears that two factors are present in the good speakers: *1.* A well defined controllable constriction zone in the region of the cricopharyngeus which will act as a pseudoglottis; *2.* an adequate sized air column below the pseudoglottis.

SUMMARY.

The location of the pseudoglottis in the laryngectomized speakers was objectively visualized by pharyngeal motion picture photography and Roentgenography.

The pharyngeal films which were made during the production of sound revealed a pattern of movement characterized by a circular sphincter-like drawing together of the walls of the pharynx, a bubbling of saliva as the sound was produced, followed by a drawing apart of the pharyngeal walls. This pattern of movement appeared to originate at the level of the cricopharyngeus.

Analysis of a series of four 10x12 inch lateral view X-ray films taken before, during and following phonation resulted in the following observations:

1. A constriction of the pharyngo-esophageal air column was present in all good speakers.

2. The constriction appeared most frequently at the approximate level of the fifth vertebra and the cricopharyngeus muscle.

3. An air column of adequate size below the area of constriction or pseudoglottis was observed in the good speakers and not in the poor speakers.

4. The formation of this column of air below the pseudoglottis, when sound is produced, appears to be analogous to the utilization of subglottal air in normal phonation.

The 14x17 inch oblique X-ray films, made at the point of maximum intake of air for speech, revealed that air is generally visible throughout the length of the esophagus, rather than in the upper part alone.

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AUDIOLOGY FOR INDUSTRY.

Colby College, Waterville, Maine, presents the Fourth Annual Course in Industrial Deafness, August 5-11, inclusive. Objective of the course will be to train personnel in initiating and in conducting hearing conservation programs in noisy industries. Seven full time instructors have been selected from authorities in this field. Class limited to approximately twenty participants.

Registrants will live on the College Campus and the tuition fee of $200.00 includes board and room. Applications should be made to Mr. William A. Macomber, Division of Adult Education and Extension, Colby College, Waterville, Me.

PURE TONE THRESHOLD AND HEARING FOR SPEECH—DIAGNOSTIC SIGNIFICANCE OF INCONSISTENCIES.*

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The lack of correlation between pure tone threshold and speech hearing may be directed in either of two ways. Hearing for speech may be worse than would be anticipated from the pure tone threshold audiogram, or it may be considerably better. Most inconsistencies observed are in the direction of speech hearing as not being so good as the pure tone threshold would indicate. This will be discussed briefly, and then the reverse relationship will be considered at greater length.

SPEECH HEARING WORSE THAN PURE TONE THRESHOLD.

In pure conduction deafness, the hearing loss for speech correlates very well with the pure tone threshold. In neural deafness, the correlation may be fairly good in some instances, but frequently the difficulty in hearing and understanding speech is much greater than is indicated by the pure tone curve.

An extreme example of the latter type is cited to illustrate the absolute necessity of doing speech tests in evaluating the hearing capacity in cases of nerve deafness (see Fig. 1). This patient was referred to me by a hearing-aid dealer who could not understand why the patient was not able to use a hearing aid in the right ear, and why only mediocre benefit was obtained from using the aid in the left air. Speech tests revealed that the patient could understand only occasional spondees in the right ear and the discrimination score in this ear was 0 per cent.

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There was marked recruitment in this ear and low frequency tinnitus was present. This was unquestionably an end-organ lesion, most likely of the hydrops type. Extreme loss of speech hearing in the presence of only moderate, flat pure tone loss is fairly common in cochlear or labyrinthine hydrops. The spondee threshold in the left ear was 50 db and the best discrimination score was 68 per cent. Recruitment in this ear was moderate in degree.

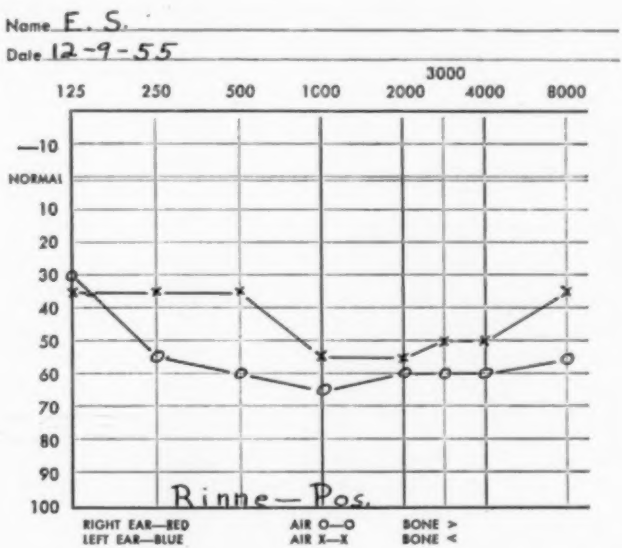

Fig. 1.

Much remains to be learned concerning the nature of physiological disturbances of end-organ function which are related to speech-pure tone discrepancies. Harris et al.[1] did a detailed study in a small group of cases, and noted that recruitment seemed to be a most important factor in such discrepancies in younger individuals. Pitch deterioration alone was not important; in fact, if recruitment was accompanied by pitch deterioration, speech-pure tone correlation was usually fairly good. The reason for this last relationship is not known.

It is not difficult to understand the importance of recruitment in speech-pure tone discrepancies if the factor of "narrowed dynamic range" expressed by Eby and Williams[2] is considered. They noted that speech was intelligible over a rather narrow range of intensity above threshold in an ear with recruitment, in contrast to a non-recruiting ear. The phonetic elements of words and sentences must vary considerably in intensity, even under calibrated laboratory conditions. The elements with greater intensity may then fall within the recruited range and seem unusually loud, while the less intense

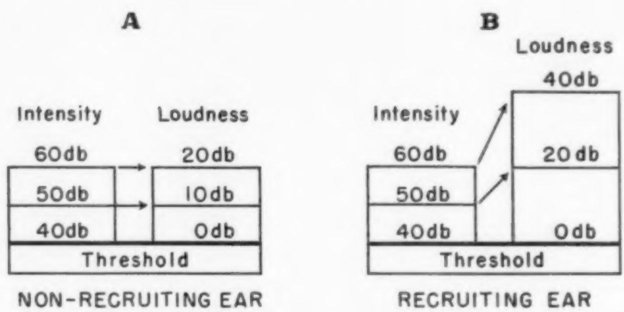

Fig. 2. These diagrams represent the relationship of loudness to intensity in a non-recruiting (A) and a recruiting ear (B). A threshold of 40 db. is indicated for each ear. In the non-recruiting ear the increase in loudness above threshold is always directly proportional to the intensity increase; i. e., when the intensity applied to the ear is 50 db. (10 db. above threshold) the loudness experienced is 10 db. At 60 db. intensity (20 db. above threshold) the loudness is 20 db. In B is represented an ear with moderate recruitment and also a threshold of 40 db. When a sound intensity of 50 db. (10 db. above threshold) is applied to this ear, the loudness experienced is 20 db. Each increase in intensity in this ear shows a disproportionately greater increase in loudness. The rapidity of increase of loudness depends on the degree of recruitment present and varies considerably from one case to another.

elements may be barely or not quite audible. Consequently, in an ear with considerable recruitment this abnormally wide range of loudness must create a state of utter confusion; *i. e.*, some elements of the presented speech seem too loud and others are scarcely audible. If for example the loudness range of ordinary speech elements just above threshold perceived in a non-recruiting ear is only 20 db, the perceived loudness of similar speech elements at 20 db intensity above threshold in an ear with recruitment has a much wider range (see Fig. 2).

As a result the intensity range which permits intelligibility of speech in an ear with recruitment is "narrowed".

Poor speech hearing is also to be expected when there is a rather abrupt drop in the audiometric curve for the higher speech frequencies, resulting in consonant speech elements not being heard. In such cases hearing for spondees may correlate fairly well, but discrimination is usually impaired. In older persons, the capacity to understand speech is usually much poorer than would be suggested from the audiometric curve. The lesion here is probably central as well as peripheral. A recent study by Bordley and Haskins[3] reveals that in such instances the PGSR shows better hearing for pure tones than does standard subjective audiometry. They considered this to be evidence of cerebral sclerosis. Experimental evidence indicates that cortical integrity is not essential for a good PGSR response. Such individuals were unable to derive any benefit from a hearing aid. Gaeth[4] has referred to this impairment of auditory function in older individuals as phonemic regression. Actually, this is probably more of a perceptive deterioration than a regression. Recruitment is not always present in presbycusis.[5] It is possible that the degree of recruitment found might be an indication of the end-organ component in the total perception problem in presbycusis.

Tinnitus frequently interferes to some extent with good speech hearing. This is particularly true of a low-pitched tinnitus, such as is frequently seen in cochlear hydrops.

SPEECH HEARING BETTER THAN PURE TONE THRESHOLD.

This relationship is relatively uncommon in private practice. Audiological observations during and after World War II indicated that such cases are on a psychogenic basis. The occasional cases that I have seen in private practice are apparently in the same etiological category. As a rule these patients have a moderately severe pure tone loss on subjective audiometry, and yet can carry on conversation at a distance of several feet with very little difficulty; this is the clue to the diagnosis. Calibrated speech tests will then verify the discrepancy between pure tone threshold and hearing for speech.

I have in the past few years observed several school children in whom the pure tone loss was much greater than the loss for speech. This relationship in adults in private practice is very infrequent. The details of one case will be cited to illustrate the clinical aspects of this problem.

A 12-year-old girl was referred to me because she was not doing well in school. An audiogram made by the school nurse showed a 55-60 db. loss in both ears. My initial audiogram on Feb. 4, 1955, substantiated this finding (see Fig. 3). Yet this girl could repeat words heard at a

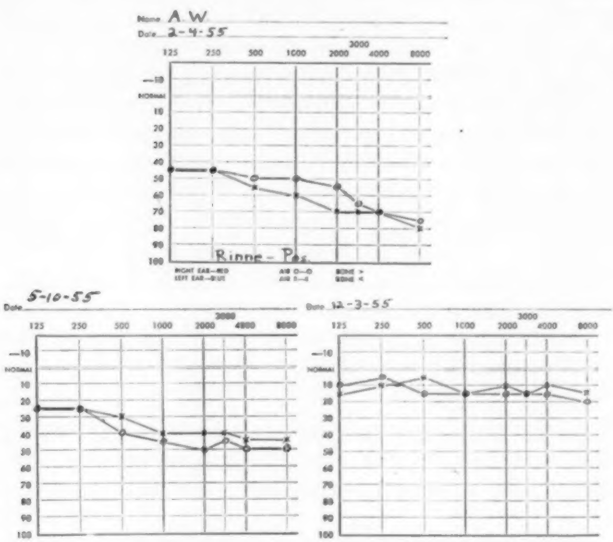

Fig. 3.

distance of 25 feet. Her otolaryngology examination was negative. A diagnosis of psychogenic deafness was made, and thorough psychological study was recommended. A follow-up hearing study was done on May 4, 1955 (see Fig. 2). There was still a moderate loss on pure tone examination. Hearing for speech showed normal threshold for spondees and a 100 per cent discrimination score. Because of uncertain calibration of the masker, a D-S test was not done. A recheck of an audiogram on Dec. 3, 1955, showed an almost normal pure tone threshold. At this time the patient seemed to have a more normal psychological attitude in contrast to a somewhat withdrawn type of personality noted at the time of her initial examination.

A brief review of her psychological background revealed that the girl had been rejected by her parents at the age of one year and placed in a foster home. At the age of three she came to live with an aunt with whom she lives at the present time. The aunt states that at the age of three the girl was not inclined to play much with other children and frequently sat by herself, talking and making facial grimaces. As far as is known she developed speech at the usual age. Shortly before the time I first saw her she had had a severe conflict with her teacher. This may have been the precipitating factor for her psychogenic deafness. When last seen recently, she was again well-adjusted in school, and it will be noted the audiogram is near normal.

In many cases the psychological problem is not as apparent as it was in this instance. It is doubtful whether a detailed psychological study is necessary or advisable in all cases; however, a superficial survey should be made, and if there is evidence of any serious difficulty, adequate psychiatric evaluation should be recommended. The otologist must use his clinical judgment on this aspect of the problem after he has completed his study.

To my knowledge there has to date been no attempt made to account for the disproportionately greater loss for pure tones than for speech in cases of psychogenic deafness. An attempt will be made here to supply a hypothesis to explain the genesis and basis of this clinical entity.

Myklebust[6] has shown that some children with otherwise normal hearing show very poor conscious response to pure tone stimulation. He explains this on the basis that a pure tone is too abstract and meaningless to arouse cortical evidence of recognition on the part of the child. He states that in the process of auditory maturation the child first shows evidence of response to speech or complex meaningful sound or noise, and that visible evidence of response to pure tones is, in some instances, delayed. Some children respond to pure tones at a much earlier age than others. This does not mean that the organ of Corti or the central pathways are not stimulated by a pure tone but merely that recognizable conscious evidence of response is delayed in developing.

It is an accepted fact that some predisposed individuals will regress to infantile patterns psychologically in certain areas of their behavior when subjected to undue stress.[7] Since the function of hearing represents to some extent a psychological reaction, it is possible that some individuals are so sensitized or conditioned as to regress in the auditory area under certain

situations of psychological stress. In other words, if an individual regresses with respect to his auditory function, he would lose first that facet of function which was last to develop in maturation; *i. e.,* conscious recognition of pure tone stimulation. If regression is severe, a moderate or severe loss for speech and other sounds as well as for pure tones will occur.

My first thought was to call the *modus operandi* of this concept of psychogenic deafness a "dematuration"; however, I think that a more appropriate and descriptive term would be "psycho-auditory regression". I believe that the greater loss for pure tones in these cases would more logically be a regression than a suppression.

DISCUSSION.

Pure tone speech hearing discrepancies are not present in pure conduction deafness. When the pure tone speech discrepancy is marked, it is usually obvious to the alert clinician on comparison of the pure tone audiogram with the patient's ability to understand conversational voice. Calibrated speech tests are necessary to establish a more exact determination of speech hearing capacity. The most common discrepancy is for speech hearing to be poorer than the pure tone threshold. Cochlear hydrops and some instances of presbycusis are particularly inclined to have considerable deterioration of speech hearing. A less common relationship is for speech hearing to be much better than the pure tone threshold. This last situation should make the clinician suspicious of an underlying psychogenic basis. If facilities are available, a D-S test and a PGSR study should be done in these cases. The PGSR (objective audiometry) would be expected to show a better threshold than standard subjective audiometry. It is hypothesized that psychogenic deafness can be explained on the basis of a "psycho-auditory regression" resulting from psychological stress in a predisposed or preconditioned individual.

SUMMARY.

1. Some form of speech testing is essential as a supplement to the pure tone audiogram in evaluating an individual's capacity to hear and understand speech.

2. Greater loss for speech than for pure tones is rather common in nerve deafness.

3. Greater loss for pure tones than for speech is highly suggestive of psychogenic deafness.

4. The concept of "psycho-auditory regression" as a basis for psychogenic deafness is proposed.

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THE AMERICAN OTORHINOLOGIC SOCIETY FOR PLASTIC SURGERY, INC.

A scientific meeting of the American Otorhinologic Society for Plastic Surgery will take place at the Waldorf-Astoria Hotel in New York City on May 18, 1956. An operative clinic will also be held during the morning of May 19th at the Montifiore Hospital.

The program will consist of medico-dental presentations and plastic surgery of the head and neck.

For further information write Louis Joel Feit, M.D., Secretary, 66 Park Avenue, New York 16, N. Y.

THE MECHANISM OF OPENING OF THE HUMAN LARYNX.*†

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MILOS BASEK, M.D.,

and

V. EPANCHIN, M.D. (By invitation),

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In a recent discussion concerning the mechanism of laryngeal closure[1] certain concepts arising out of Roentgenographic investigations were presented. It was shown that a ball-valve type of mechanism occurred, produced by pressure of the preepiglottic body against the upper surface of the vestibular folds and brought into action when the distance between the larynx and the hyoid bone was reduced. Evidence was presented suggesting that extrinsic laryngeal muscles were responsible for this movement and were thereby able to close the larynx even when the intrinsic muscles supplied by the recurrent laryngeal nerves were paralyzed.

Electromyographic studies have produced additional evidence supporting these ideas. In conjunction with Roentgenographic and cinematographic analysis of vocal cord movements, the findings also indicate that current views on the mechanism of opening of the larynx and glottis[2] require modification. The evidence concerning the mechanism of opening is presented here.

METHODS.

The subjects were three male physicians in normal health.

Electromyography: Action potentials from laryngeal muscles were recorded during normal and deep respiration. The muscles studied were the sternothyroid, sternohyoid, thyro-

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hyoid, cricothyroid and vocalis, and the rectus and external oblique muscles of the abdomen. The muscles were identified by reference to their point of attachment to skeletal structures. Concentric bipolar needle electrodes were inserted through skin wheals made with one per cent procaine into the muscles in a plane closely parallel to the long axis of their fibers. Six muscles were studied simultaneously. The potentials were led to an eight channel Grass model III ink-writing oscillograph. The seventh channel recorded sounds through a microphone placed in the subject's mouth. The eighth channel registered a signal operated by the subject's hand and arranged to light simultaneously a lamp visible in the field of a 16 mm. motion picture camera. This camera photographed the movements of the anterior prominence of the thyroid cartilage. The signal was used to mark the start and end of each maneuver.

Roentgenograms: Lateral and anteroposterior exposures were made at the end of normal expiration, enforced expiration, and at the end of deep inspiration. The technique for lateral views was: tube film distance 72 inches, centered 1.5 cm. behind the thyroid cartilage notch, 72 kv., 400 ma., 1/10 second. The subject sat up with the head steadied by a strap. Anteroposterior laminograms were obtained in a plane 2 cm. behind the thyroid cartilage notch, tube film distance 30 inches, 50 milliamps for 3 seconds, 75 kv., patient recumbent.

Motion Pictures of Vocal Cord Movements: The larynx was visualized by a laryngeal mirror and photographed at 16 frames per second during phonatory and respiratory movements.

RESULTS.

Electromyograms: There is continuous activity of all the intrinsic (cricothyroid and vocalis) and extrinsic (sternothyroid, sternohyoid and thyrohyoid) muscles of the larynx studied, but the intensity of activity in the various muscles depends upon the laryngeal movement that is being performed.

In quiet respiration (see Fig. 1) there is some activity in all the muscles of the larynx throughout both inspiration and expiration.

With stronger respiratory efforts (see Fig. 2) there is increased activity in all the laryngeal muscles and a definite dif-

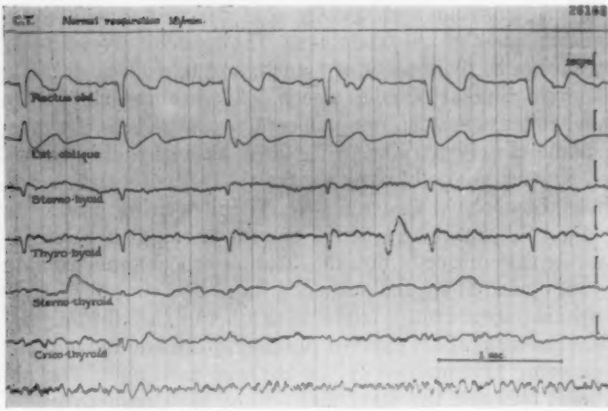

Fig. 1. Electromyograms of abdominal and laryngeal muscles during quiet respiration. Subject C. T. There is slight activity continuously in all the laryngeal muscles. The large deflections in the abdominal tracings are due to electrocardiogram pickup. The bottom tracing in Figs. 1 to 4 recorded currents from a microphone near the subject's mouth.

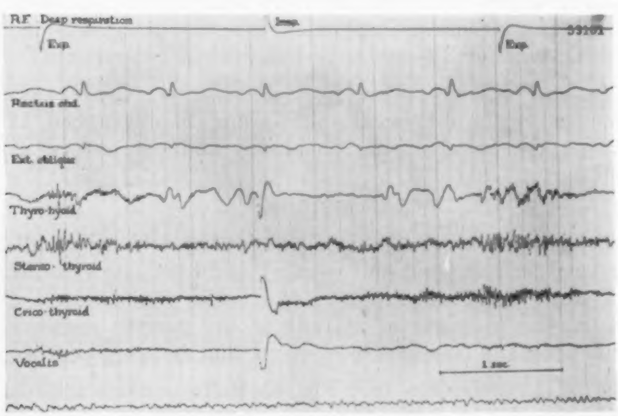

Fig. 2. Electromyograms during deep respiration. Subject R.F. There is considerable activity in the sternothyroid throughout both inspiration and expiration. Thyrohyoid activity is marked only during expiration. Note the increased tone in the vocalis during expiration. Motion pictures showed the larynx moving downward with inspiration and upward with expiration.

Fig. 3. Electromyogram of strong inspiratory effort. Subject C.T. Inspiration is accompanied by increased activity of laryngeal muscles, more marked in the sternothyroid than in the thyrohyoid.

Fig. 4. Electromyogram of strong expiratory effort. Subject C.T. Expiration is accompanied by a marked increase in thyrohyoid activity.

ference between the inspiratory and expiratory patterns becomes visible. During inspiration sternothyroid activity is well marked whereas the thyrohyoid is relatively quiescent. With expiration there is increased activity in both muscles, but the increase appears most pronounced in the thyrohyoid; there is also a rise in cricothyroid and vocalis activity.

In forced respiratory movements there is increased tone in all the muscles in both phases of breathing; however, in forced inspiration (see Fig. 3) the increased activity is more marked in the sternothyroid than in the thyrohyoid muscle. Motion pictures show that at this time the larynx was moving down (caudad). The rectus abdominus and external oblique are quiescent. With deep expiration (see Fig. 4) there is a striking

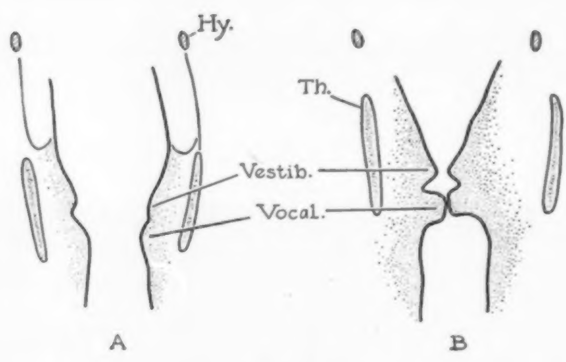

Fig. 5. Anteroposterior laminograms of larynx. Subject R.F. (A) Deep inspiration. (B) Expiration. During inspiration there is wide separation of the vocal and vestibular folds. The thyroid cartilage and hyoid bone are also widely separated. In expiration both distances are smaller.

increase in thyrohyoid potentials, and activity is also registered in the abdominal muscles. At this time the larynx was moving upward.

Roentgenograms: The anteroposterior laminograms showed that there is wide separation of the vocal and vestibular folds in inspiration (see Fig. 5A); in expiration (see Fig. 5B) the folds were nearer the midline. The lateral Roentgenograms

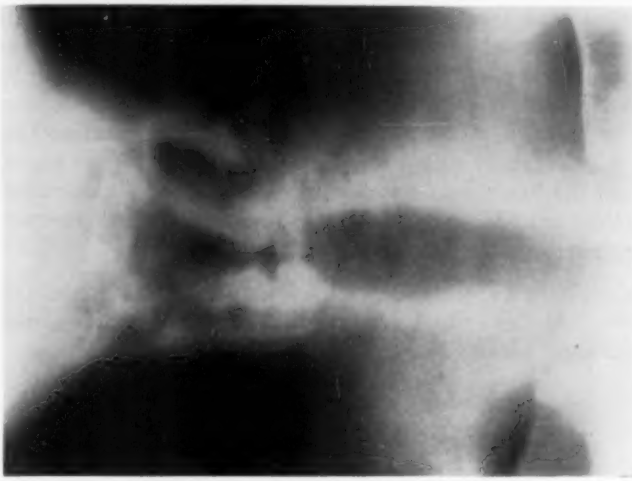

Fig. 5B.

Fig. 5A.

demonstrated that in inspiration (see Fig. 6A) the larynx moves downward away from the hyoid bone; the anteroposterior diameter of the aditus and vestibule was increased by elongation and forward displacement of the pre-epiglottic body and by backward tilting of the arytenoids. In expiration (see Fig. 6B) the reverse change occurred; the entire larynx moved toward the hyoid, the pre-epiglottic body appeared shortened and thicker and displaced backward, resulting in anteroposterior narrowing of the vestibule.

In expiration the ventricle of the larynx was horizontal and narrow. At the end of deep inspiration the ventricle sloped upward and backward and was increased in width.

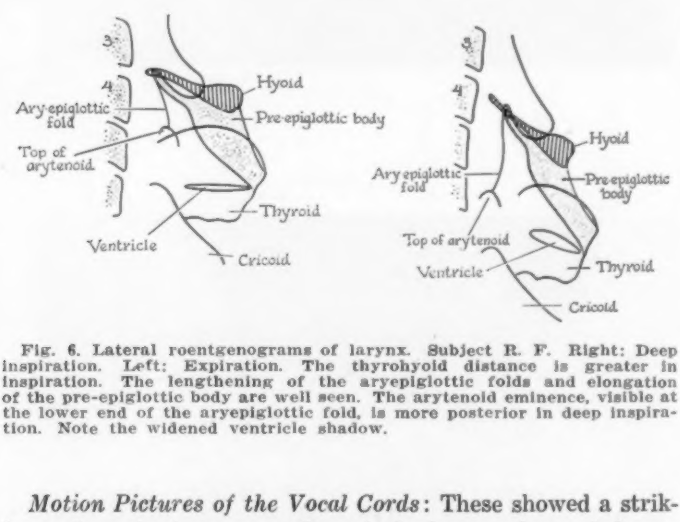

Fig. 6. Lateral roentgenograms of larynx. Subject R. F. Right: Deep inspiration. Left: Expiration. The thyrohyoid distance is greater in inspiration. The lengthening of the aryepiglottic folds and elongation of the pre-epiglottic body are well seen. The arytenoid eminence, visible at the lower end of the aryepiglottic fold, is more posterior in deep inspiration. Note the widened ventricle shadow.

Motion Pictures of the Vocal Cords: These showed a striking and constant sequence of events during opening and closure of the glottis. The records obtained by us at 16 frames per second are in agreement with those of the high speed motion picture of the human vocal cords at 1,000 frames per second made by the Bell Telephone Company, through whose courtesy Fig. 7 is reproduced. In the open glottis during quiet respiration the vocal processes were almost parallel to each other and

Fig. 6B.

Fig. 6A.

Fig. 7. Motion picture of glottic movements at the start (A-F) and end (G.K) of phonation. The vocal processes (indicated by heavy lines in the sketches) retain a virtually constant direction throughout. The interval between frames is approximately 1/40 second (Bell Telephone).

pointed directly forward (see Fig. 7A). As the glottis closed the vocal processes came together but maintained a constant forward direction throughout (see Fig. 7-B to F); there was no sign of internal rotation. When the glottis opened the vocal

processes moved apart but retained the same forward direction (see Fig. 7G to J) until just before the maximum enlargement of the lumen (see Fig. 8A to C). The vocal processes then began to diverge, forming an angle of 30° (see Fig. 8D). At the same time the arytenoids were seen to tilt backward and the anteroposterior diameter of the vestibule became enlarged.

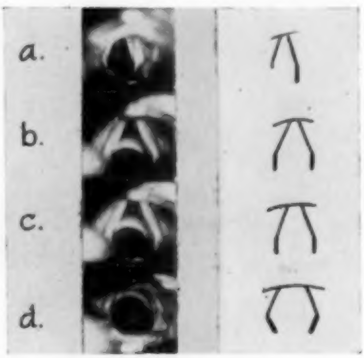

Fig. 8. Opening of glottis during deep inspiration. (A-B-C) The vocal processes remain parallel. (D) At the end of the lateral excursion the vocal processes diverge through an angle of 30°.

DISCUSSION.

The motion pictures of vocal cord movement clearly indicate that changes in size of the glottis are accompanied by sideway sliding movements of the arytenoid cartilages. There is no suggestion of internal rotation at any time, nor of external rotation until the maximum enlargement of the glottis is approached, at which point the vocal processes appear to diverge and the arytenoids tilt backward. This occurs in deep inspiration at a time when the ventricle slopes upward and backward (see Fig. 6A). The divergence is not due to external rotation but is a result of backward tilt of the arytenoids; when seen from above, foreshortening gives this an illusory appearance of rotation. The change in direction of the ventricle indicates that its posterior limit, namely the vocal proc-

ess, has moved upward. Since the thyroid and cricoid cartilages have not moved relative to each other, the movement of the vocal process must have occurred by backward tilting of the arytenoid at the crico-arytenoid joint. This joint is cylindrical,[5] with the long axis sloping down at an angle of 45° to the horizontal (see Fig. 9). Backward tilt of the arytenoid around this axis must, therefore, carry the vocal process not

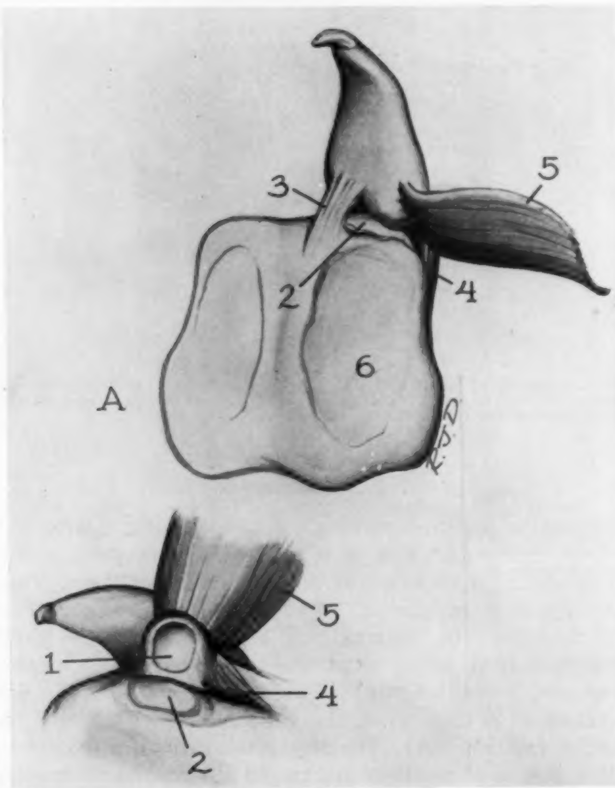

Fig. 9. Right crico-arytenoid joint of a man. Note the slope and elongation of the cricoid facet (2) and the corresponding concavity of the arytenoid facet (1). The attachments of the posterior crico-arytenoid (5) and lateral crico-arytenoid (4) do not provide leverage for rotation.

only upward but also outward.[4] Seen from above, the outward component appears as divergence. No external rotation is involved.

The motion pictures and X-ray evidence afford no support for the idea that the glottic opening is governed by rotation of the vocal processes; changes are almost entirely due to lateral sliding movements of the arytenoids along the crico-arytenoid joints. This conclusion is supported by observations on three fresh cadaver specimens. In preparations consisting of the hyoid bone, larynx and upper part of the trachea, distraction of the specimens by pulling the trachea and pre-epiglottic body in opposite directions caused separation of the arytenoids and enlargement of the glottis similar to that seen in the motion pictures. Rotation of the vocal processes did not occur. On release of the traction the vocal cords returned to the cadaveric position.

Recognition of the mediolateral gliding motion of the arytenoid during opening of the glottis leads to the question, what muscle or muscles are responsible for this movement? It must be pointed out that in man the muscles attached to the arytenoid cartilages, including the posterior crico-arytenoids, do not originate lateral to the arytenoids and, therefore, cannot by themselves produce a lateral sliding movement of these cartilages. The means by which the arytenoids are drawn apart, therefore, require further consideration.

Signs of the mechanism involved are discernible in the lateral Roentgenograms. In Fig. 6A it can be seen that the aryepiglottic distance is increased by the downward excursion of the larynx and that the upper border of the ventricle is bowed upward; this indicates that the vestibular fold which forms the border has been pulled upward. The vestibular folds continue into the aryepiglottic folds which run from the arytenoids upward and outward to the sides of the epiglottis. When the aryepiglottic folds are stretched, as by descent of the larynx, they must exert an upward and outward pull on the arytenoid cartilages and vestibular folds. This makes the vestibular folds arch upward and draws the arytenoid cartilages laterally, carrying the vestibular and vocal folds away from

the midline (see Fig. 10). When the end of the lateral excursion of the arytenoids is reached the same upward and outward pull apparently makes the vocal processes tilt up and out, causing the body of the arytenoid to incline backward and enlarging both the anteroposterior diameter of the vestibule and transverse diameter of the glottis. In addition descent of the larynx causes stretching of the pre-epiglottic body in the anterior wall of the vestibule, making it lie more vertically and adding to the expansion of the anteroposterior diameter during inspiration.

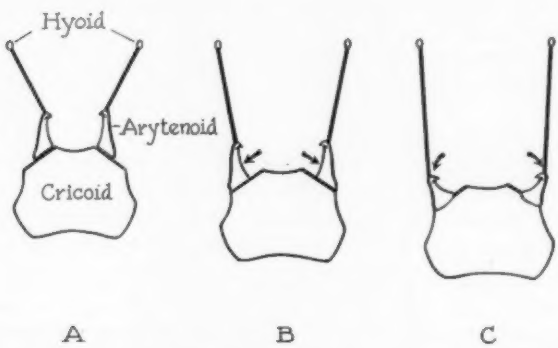

Fig. 10. Diagram to show the effect of stretching the aryepiglottic folds on movements of the arytenoid cartilages. (A) Expiration. (B) Inspiration. (C) Maximum inspiration. In inspiration the larynx moves down, away from the hyoid; the aryepiglottic folds become stretched and pull the arytenoids outward. In extreme inspiration the stretch acts on the vocal processes (not visible in the diagram) and tilts the arytenoid backward.

According to the electromyograms, the sternothyroid muscle is at peak activity during the inspiratory phase of respiration, just when the lumen of the larynx is enlarging in all directions. The action of this muscle tends to pull the larynx away from the hyoid with consequent stretching of the aryepiglottic folds and separation of the arytenoid cartilages (see Fig. 10). Since this action occurs with each respiration it seems reasonable to regard the sternothyroid muscle as playing a major part in opening the glottis and larynx during inspiration. Similarly the thyrohyoid muscle, at peak activity during expiration, pulls the larynx toward the hyoid bone and reduces the

stretch on the soft tissues, thus allowing or causing them to fold and approach each other. The thyrohyoid is, therefore, considered to play an important part in narrowing the glottis during expiration.

According to these findings respiratory movements of the larynx and glottis are produced by a mechanism comparable to a bellows. The folds of the bellows are the vestibular and vocal folds (see Fig. 11). When the bellows opens the folds are stretched, and the space between them is increased. In the larynx such a stretch is produced during inspiration by downward movement of the larynx. Conversely, when the bellows closes the folds are nearer together, and the lumen is reduced;

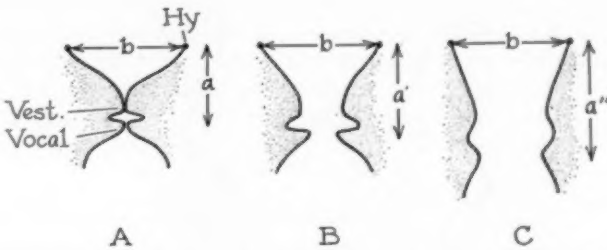

Fig. 11. Tracings of anteroposterior laminograms of larynx. Subject T.T. (A) Closed. (B) Expiration. (C) Inspiration. A bellows type of action is exerted on the vocal and vestibular folds by vertical movements of the larynx. As distance a, a′, a″, increases the larynx opens at the level of the folds. Diameter b remains constant throughout.

in the larynx this occurs during expiration when the organ moves upward. Opening and closure of the glottis during respiration is, therefore, interpreted to be the result of up-and-down movements of the larynx as a whole, controlled by extrinsic muscles, especially the sternothyroid and thyrohyoid. Downward movement of the larynx, produced by the sternothyroid, pulls the larynx away from the hyoid and tends to unfold the vestibular and vocal folds, thereby widening the glottis. On the other hand, the thyrohyoid draws the larynx and hyoid together, causing folding of the laryngeal walls and tending to narrow the glottis. This explains the observations that deeper breathing is accompanied by an increased vertical excursion of the larynx[5] and by a wider opening of the glottis.[6]

The role of the crico-arytenoid muscles in glottic movements though essential is probably more indirect than usually supposed, namely to support the vocal process by stabilizing the base of the arytenoid cartilage. The arytenoid cartilage resembles a triangular pyramid resting on one angle of its base at the crico-arytenoid joint (see Fig. 12A); the crico-arytenoid muscles inserted at the joint can be regarded as braces whose function is to stabilize this precarious balance. The forward pull of the vocalis is opposed by the posterior crico-arytenoid, but this creates a torsion moment or torque which it seems the function of the lateral crico-arytenoid to counteract. Such an interpretation explains the continuous activity found in electromyograms of the human vocalis and cricothy-

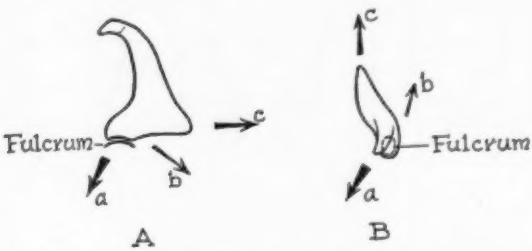

Fig. 12. Forces acting on the base of the arytenoid cartilage. (a) Posterior crico-arytenoid. (b) Lateral crico-arytenoid. (c) Vocalis. The thickness of the arrows is roughly proportional to the size of the corresponding muscles. The fulcrum of any resultant movement is at the posterolateral corner of the base. The forces appear better adapted to controlling anteroposterior tilt than transverse rotation.

roid muscles. It may be surmised that there is a balancing continuous activity in their opponents; *i.e.*, in the crico-arytenoids.

The work of Murtagh and Campbell[7] indicates that continuous tone is present in both groups of muscles in goats. It may be concluded that stability of the arytenoid cartilages probably requires continuous tonic activity in all the intrinsic muscles of the larynx, and that it is upon this background that the bellows mechanism operated by extrinsic muscles is superimposed in man. The relation of these findings to the manifestations of recurrent laryngeal nerve paralysis is being investigated.

SUMMARY.

Motion pictures of human vocal cord movements show that opening and closure of the glottis are accompanied by sliding movements of the arytenoids to and from the midline. Rotation of the cartilages does not occur.

Roentgenographic evidence demonstrates that the rhythmic movement of the larynx down and up the neck with respiration causes alternate folding and unfolding of the laryngeal soft tissues, after the fashion of a bellows, and impresses a mediolateral sliding motion on the arytenoids.

Electromyography of intrinsic and extrinsic laryngeal muscles reveals the presence of continuous tonic activity in the intrinsic muscles. It is suggested that continuous balanced activity in these muscles is necessary to stabilize the crico-arytenoid joint. The pattern of activity in the extrinsic muscles indicates that these play a major role in controlling the lateral excursion of the arytenoid cartilages and glottis.

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RECENT ADVANCES IN DIAGNOSIS AND TREATMENT OF MIDDLE EAR DEAFNESS.*†

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During the last few years we have been interested in the treatment of middle ear deafness by prosthetic appliances.[2,3] It was found that some patients may have a good improvement of the hearing function when a prosthesis is used in the tympanum; however, about one-half of the patients do not benefit from a prosthesis. While the successfully fitted patients represent a satisfying and happy group, the unsuccessful case is more thought-provoking and more challenging.

The present study was prompted to analyze the unsuccessful prosthesis patient.

The problem can be formulated as follows: The attempt is being made to improve hearing in non-otosclerotic sound conduction lesions. If a prosthesis is not helpful it is assumed that there exists more than one pathological factor within the sound conduction system. For example, we believe if a patient has an uncomplicated eardrum perforation a closure of the perforation would overcome the functional loss. If the audiometric curve does not change, we assume a second, hidden functional defect which prevents the improvement of hearing. In order to analyze and to find this hidden focus, the otologist must possess a high degree of knowledge of the function in the middle ear.

The problem is considerably more complicated than in otosclerosis. Otosclerosis is simple, even monotonous, insofar as analytical work-up of the function is concerned.

The lesion, so far as the functional aspect is concerned, is always in the area of the stapes footplate. The *tissue* pathology of otosclerosis is osteospongiosis, while the *functional*

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pathology is stapes ankylosis. The tissue pathology cannot be diagnosed clearly in life; however, the functional diagnosis of stapes ankylosis is readily possible. The otologist in dealing with otosclerosis is accustomed to treat the functional entity of stapes ankylosis nearly synonymously with otosclerosis.

There are two principles which have guided the surgical treatment of stapes ankylosis. Speaking in military terms, the ankylosis of the footplate represents a roadblock in the path of sound conduction. There are two ways in military tactics to overcome a roadblock: one means is to circumvent it; this is the idea of fenestration. Second, it can be decided to ram right through the roadblock; this is the concept of mobilization.

For some reasons, which are not always clear or valid, adhesions in the middle ear and their consecutive hearing impairment have been considered unavoidable, unpreventable and unalterable.

The point is, this opinion no longer is unchallenged, and serious attempts are being made to improve non-otosclerotic sound conduction losses.

When fenestration was developed, several stages had to be transgressed:

First, the initial step was the basic physiological recognition that an opening in the vestibular part of the inner ear can be helpful in stapes ankylosis.

The second step was the selection of the site, size and shape of the surgical fenestra.

The third step was the solution of maintaining the opening.

Finally, the audiometric problem of selecting patients and predicting results had to be studied.

We can learn much from the historical steps in fenestration development. It does not take too much imagination to predict that the development of non-otosclerotic surgery has to go through similar steps. Fenestration surgery has already accomplished the training of the otologist by teaching him to operate by microscopic enlargement. Second, it has given him

the dental drill; and last, but not least, the much greater care, exactitude and alertness in every step of the operation. The modern oto-surgeon has gone far beyond the crude and simple technique of "incision and drainage" of the simple mastoid operation.

The surgeon must be audiologist, physiologist, plastic surgeon and experimenter, if he wants to work in tympanal plastic surgery.

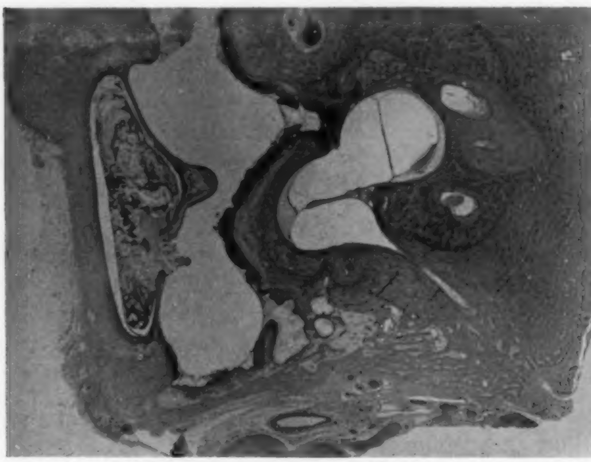

Fig. 1. Photomicrograph of the middle ear of patient A.B. Magnification 8x. Vertical section. The pathology is characterized by inflammatory and desquamated debris in the external auditory meatus; second, by an eardrum perforation in the inferior half of the pars tensa and swollen mucous membrane on the promontory. The inner ear shows no visible histopathology.

It is not advantageous that non-otosclerotic surgery be performed first and the selection of patients be learned last. The diagnostic work-up of patients for proper selection of patients must precede the actual surgery. This is the motive for this paper.

There are a number of tests which are helpful in analyzing each individual case. Inasmuch as tympanic plastic procedures are varied and have to be adapted to each individual case, the otologist must command the techniques of these tests, and he

must possess the knowledge of physiology to subdivide the middle ear pathology.

Inasmuch as therapeutic procedures in the middle ear may be able to overcome certain features of conduction losses, while failing in others, it seems wise to subdivide the clinical entity "conduction deafness" into several sub-entities which produce components of deafness and must be added together

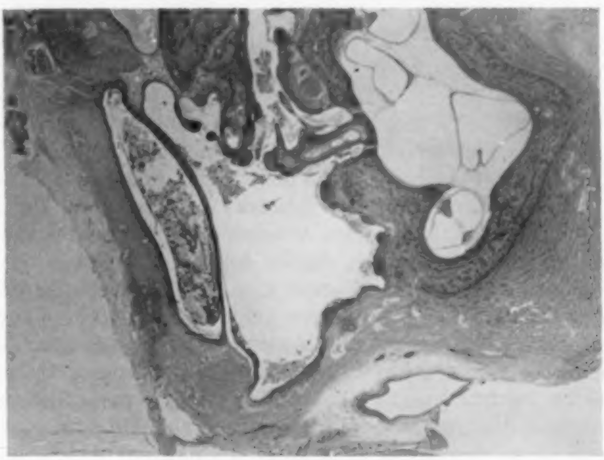

Fig. 2. Photomicrograph of the same ear under same magnification as in Fig. 1. This section shows extensive adhesive changes in the epitympanum involving the head of the hammer and the body of the incus. Connective tissue strands are seen in the oval niche. Ring band shows no abnormality.

when the final total result of the middle ear deafness is assessed.

Figs. 1 and 2 show the histology of patient A. B. This patient suffers from extensive middle ear pathology, but shows a normal inner ear. When a hearing test is performed on this patient the sum total of all middle ear defects is recorded. It seems essential to know what percentage of the hearing loss was caused by the accumulation of pus and debris in the outer ear; how many decibels was the signal attenuated on account of the eardrum perforation; to what extent, expressed in decibels, did the conduction of sound in the middle ear suffer from

the epitympanic adhesions, and to what extent was the motility of the stapes embarrassed by the swelling of the mucous membrane on the promontory, especially in the area of the oval window niche. Finally, the otologist should analyze the result of any impediment of the phase relation between the two windows. Hypothetically, the course of sound conduction can be mapped in this case about as follows:

The stimulus impinges on the ear with 100 per cent intensity, the plug in the external canal attenuates, *e.g.,* 10 per cent, the remaining 90 per cent sound energy is attenuated again by a further 18 per cent loss due to the perforation of the eardrum. After the two losses of 28 per cent, the remaining intensity is further curtailed by the adhesions in the epitympanum which embarrass the oscillations of the head of the hammer and of the body of the incus. This loss, assumed to be 25 per cent, diminishes the intensity of the signal further. Finally, the pathology of the window area attenuates the intensity further; therefore, finally delivered to the inner ear and transduced into nerve perception, is a message the intensity of which represents the remainder after four or five distinct and locally separated subtractions. The audiogram represents the sum total of these losses. The otologist, if he aspires to the treatment of post-inflammatory, non-otosclerotic conduction deafness, should attempt and should be able to differentiate as completely as possible the parts of which the total hearing impairment was composed.

The following sub-entities should be differentiated:

1. Pathology of the air-eardrum boundary (Drum Pathology).

2. Pathology affecting the sensitivity of the ossicles (Ossicular Pathology).

3. Non-otosclerotic stapes fixation. A disease of the mucous membrane consisting in calcifications of the fenestral area (Stapedial Pathology) (*e. g.,* Tympanal sclerosis of Troeltsch).

4. Pathology in the two window niches (granulations, secretion, tumors, etc.) (Fenestral Pathology).

5. Pathological function of the tube (Tympanal and airspace Pathology).

The following instruments and tests are used for differential diagnosis:

1. Latex rubber to use as artificial eardrum and to determine the functional effect of closure of a perforation.

2. The acoustic probe. This is a point-like sound source which can be applied to various points in the middle ear or on the eardrum. The history of the acoustic probe begins with Pohlman. The probe was a bamboo-like rod which was pushed through a cardboard. The otologist talked against the cardboard and applied the probe to various points in the middle ear. The patient noticed when a yielding spot on the promontory was touched, that the voice of the examiner seemed to increase.

It was an important improvement when Zoellner[5] utilized an audiometric sound source. The advantage is that the tone can be maintained as long as desired. Second, by using attenuation, a measurement in db. can be performed at various intra-otic locations. Intra-otic threshold readings can be taken. We have gone a bit further and have tried to emancipate ourselves from the audiometer and the hearing room and carry our own sound source right with the probe.

3. The tympanal prosthesis is used for elucidation of fenestral pathology. A cotton plug soaked in oil is inserted into the round window niche where it provides sound shadow for the round window; thus, preferential sound conduction is re-established. The obtained hearing gain indicates good function of the opposite window.

4. The Gellé test,[1] now used in quantitative form following the techniques of Thullen.[4]

In 1881 Gellé suggested a specific diagnostic test which was supposed to permit diagnosis of stapes ankylosis. He connected a Politzer balloon with a tube and adapter for airtight insertion into the outer ear canal. When he placed a tuning fork on the balloon the tone could be heard by the patient through the air and the wall of this system. When the balloon was compressed, and thereby the eardrum and ossicular chain

pushed medially, then the loudness of the tone diminished. Gellé interpreted this mechanism as a pressure on the oval window ring band and a proof of stapes mobility. This he named a positive result. The opposite, a negative Gellé test, is the non-appearance of a loudness attenuation for bone conduction on such pressure. Recent re-study and recent improvements of the Gellé test by Thullen make the Gellé test more

Fig. 3. Black and white copy of a Kodachrome transparency of an eardrum picture. Patient Mrs. F., 45-year-old woman. The pathology of this eardrum is characterized by a round perforation in the inferior posterior quadrant of the pars tensa. Extensive calcareous deposits. When a rubber membrane was placed over the perforation, no hearing improvement occurred. The next step in testing such a prosthesis failure is to test the intactness of the ossicular chain by an acoustic probe. After that blocking the round window niche by an ointment plug should be attempted and the audiological effect of the blocking be noted. Improved hearing after the round window niche has been blocked proves a mobile stapes.

valuable for the clinician. As a matter of fact, during the decade after the war, most otologists had a hazy recollection of the Gellé test but did not use it. Today, with the Thullen audiometric and thereby quantitative improvements of the Gellé test, the otologist can utilize otherwise not available information.

The procedure, as advised by Thullen, is executed as follows: A rubber hose with inflatable cuff is inserted into the outer

ear canal. This insures airtight insertion. Coaxially with the tube a tone and a pressure change can be produced. Measurements up to + and – 100 mm. Hg. are possible. The pressure in the outer canal, upon which the patient can no longer hear the tone, is recorded. This pressure is one possible end-point for measurements, or the number of db by which the threshold of audibility changes, can be measured.

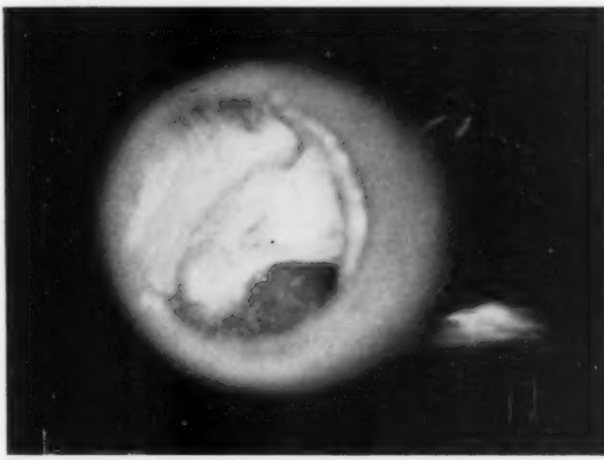

Fig. 4. Black and white print of an eardrum Kodachrome transparency. An eardrum with pathology very similar to that of the patient shown in Fig. 3. Extensive calcareous plaques in the pars tensa. Perforation of similar size and location as in Fig. 3. Functionally, however, a completely different result was obtained. Closing the perforation increased hearing considerably. The comparison of these two cases demonstrates that the inspection of the eardrum is inadequate to analyze the middle ear pathology. Functional tests are able to furnish additional information.

At present, our main interest is focused on those patients in whom a favorable effect of a tympanal prosthesis is anticipated but fails to be achieved. What physiological condition exists to prevent the principle on which the tympanal prosthesis acts? The principle is the restoration of preferential sound conduction to the oval window. The tympanal prosthesis prevents the simultaneous stimulation of both windows by sound of equal or near-equal phase (see Figs. 3, 4, 5). The logical assumption is that the oval window is not sensitive enough to execute the enforced vibrations; therefore, it is recommended

that we test the oval window by touching it with the electronic Zoellner probe. If touching the oval window niche reveals a strong response, a sensitive oval niche is assumed. It is advised to go back to the tympanal prosthesis and block the oval window. We deal now with a system in which the round window may become the port of entry for the sound, and the oval window may be sealed off by the sound shadow effect. Some patients have benefited from oval window fittings.

Fig. 5. A black and white print of an eardrum Kodachrome portrait. The perforation in the posterior aspect of the pars tensa has about the same size as in Fig. 3 and Fig. 4. In this case nature did a tympano-stapedo-pexie. There was good hearing considering the extensive pathology. It is likely that the ossicular chain was interrupted but a columella effect established by the adhesion of the stapes head onto the pars tensa.

In case the oval window is found insensitive, surgical cleansing of the oval window niche may be indicated.

It is not advisable, according to Zoellner, to probe and to manipulate too much in the round window niche.

Another reason for failure of the tympanal prosthesis is cystic degeneration of the promontorial wall.

A Politzer maneuver is indicated and advised as the next step. The reason is that there may be cystic changes or ad-

hesive attachments of the drum membrane onto the promontory adjacent to and including the niche of the round window. When the Eustachian tube can be successfully inflated a ballooning of the adherent eardrum may result. A maintained although reduced airspace, comprising the tubal ostium, the hypotympanum and round window area is created. This reduced airspace has been named "the small tympanum", and its creation by Politzer inflation is functionally improving and diagnostically and prognostically significant. It can be produced surgically by a skin flap which covers the hypotympanum, the tubal ostium and the round window.

SUMMARY.

1. Surgical procedures for accomplishing improved hearing function have been developed during the last few years and more are to be anticipated.

2. As the experience with the selection of fenestration patients has shown, careful audiometric and physiological tests must precede the surgery in order to insure proper selection of patient and procedure.

3. The pathology of non-otosclerotic conduction type deafness is more varied as to site, extent and tissue pathology than otosclerosis. It must be recognized that otosclerotic stapes fixation is rather monotonous. There is always a loss of elasticity of the annular ligament; therefore, site and tissue pathology is constant. Similarly, the idea of overcoming this pathology is monotonous. Bypass the oval window as in fenestration surgery or ram through it like in mobilization. Because of this simplicity the surgical treatment of otosclerosis did not demand any great knowledge of the pathological function of the middle ear.

4. In contradistinction, cases of non-otosclerotic middle ear deafness are much more varied as to their underlying tissue pathology, the locations in the middle ear, and the patho-physiological principles by which they are caused.

5. It is suggested that we recognize the following sub-entities of middle ear deafness:

a. Diseases of the eardrum (Functional pathology of the air-eardrum boundary).

b. Diseases of the ossicular chain (Ossicular pathology).

c. Diseases of the stapes (Stapes pathology).

d. Diseases of the windows (Fenestral pathology).

e. Diseases of the tube and tympanal airspaces (Airspace pathology).

6. Finally, the selection of surgical procedures should be based on a knowledge of the individual factors in each patient. The following treatment procedures are being developed:

a. Closure of an eardrum perforation by plastic flap.

b. Freeing epitympanal structures from scars or sclerotic membranes.

c. Freeing the oval window from obstructing tissues like granulations, scars and membranous sclerosis (Zoellner).

d. Tympano-stapedo-pexie. This method mentioned already by Stacke and convincingly shown in this country by Juers.

e. Creation of a columella (Wullstein).

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CHANGING CONCEPTS IN AUDIOLOGY.

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Audiology, as presently conceived by many, began primarily after World War II, and since that time there has been a new emphasis and interest in the problems of people with impaired hearing. This new emphasis was given substantial impetus by the rehabilitative needs of hearing impaired veterans. While this has been advantageous, certain problems have arisen as a result. One of the most generally accepted functions of an audiology center became that of dealing with amplification methods and procedures. The hearing aid became a focus of interest and perhaps was uncritically emphasized as a panacea for the hearing impaired individual. In any event, most programs gave considerable attention and study to the question: "What is a good hearing aid and to whom should it be fitted?" To a certain extent this meant that audiological centers became hearing aid evaluation centers. Although such programs brought benefits to many people and fostered advancement of knowledge, it is now apparent that they had limitations, both theoretically and clinically.

CONCEPTS ARE CHANGING.

During recent years audiological centers have changed their emphasis from major concern with hearing aids to broader aspects of auditory disorders. The significance of an auditory impairment now is viewed as being pervasive and inclusive. Other aspects of the problem of deafness are being emphasized; the concept of audiology is changing. Audiology is not limited to the problem of peripheral deafness; that is, deafness which is the result of deficiencies of the hearing mechanism. Currently audiology emphasizes the more inclusive concept of auditory disorders and auditory behavior. It is concerned with the total problem of inability to receive and to profit normally from sound, irrespective of the nature of the pathology involved. At the broadest level this means that

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audiology is a science which is concerned basically with the receptive phase of language development and acquisition. It deals with all aspects of hearing but is fundamentally concerned with the reception and comprehension of spoken language. The new concept emphasizes all types of auditory disorders, disturbances of auditory behavior, the pathology of hearing, as well as the study of normal hearing and its significance to the human being.

TYPES OF AUDITORY DISORDERS.

Deafness.

Impaired hearing acuity in infancy impedes the reception of speech and thereby disturbs a basic maturational factor in human development, the acquisition of verbal symbols called speech. The effect of this deprivation is pervasive and influences the total behavior of the individual. Likewise, a hearing impairment which occurs in later life causes the individual considerable distress through isolation, increased anxiety and in other ways. These problems continue to receive profound consideration and study, not only from the point of view of the nature of deafness but also relative to its meaning and impact on the individual. As concepts change, however, it is necessary to emphasize other auditory disorders which affect reception of sound.

Disturbances of Auditory Perception.

Auditory perception is the way in which the human being organizes, structures and uses the sounds in his environment. In order for the individual to profit normally from auditory experience he must have normal auditory perceptual capacities. Auditory perception includes the constant awareness of all sounds in the environment, and the ability to select the appropriate sounds from this conglomerate world of sound. All sounds in the environment are not equally useful simultaneously. Those which are not useful at a given moment must be held in the background of attention while those which are immediately relevant must be brought into the foreground.

A revealing example of this process is seen when an individual is listening intently; he is deliberately attempting to make

a particular sound come into the foreground of attention. In order to do so he simultaneously attempts to keep all other sounds in the background. This is referred to as *listening behavior.* It is characteristic of children who have disturbances in auditory perception to be able to hear but to be unable to listen. They cannot respond to their auditory world selectively and meaningfully; they cannot structure their auditory world. As a result they respond to all sounds as though they are of equal importance simultaneously. Such children often are seriously distractive, disinhibited and unable to give sustained attention. Because this is a basic threat to the adjustment, if not to the survival of the organism, some of these children suspend their use of hearing and intermittently appear to be deaf. Such confusion of auditory perceptual incapacities with deafness is enhanced by the fact that typical tests of hearing assume auditory perceptual integrity. In other words, most tests of hearing assume ability to listen. Because individuals who have disturbances of auditory perception cannot listen, they will be erroneously classified as hearing impaired if such test results are interpreted literally.

Another significant factor audiologically is the relationship of auditory perception to the use of hearing aids. Perhaps one of the most difficult aspects of the use of a hearing aid is the manner in which it affects the individual's ability to structure the world of sound. Apparently the hearing aid alters the normal auditory perceptual processes in a critical manner. The hearing aid user seems to be confronted with a difficult auditory perceptual task which has been studied only superficially. Presently the typical hearing aid or auditory training unit makes it possible for the user to function only in a foreground manner. This can be considered as a basic reason for the user's not being able to understand speech in a noisy environment or when he is in a group conversational situation.

Through a hearing aid the fundamental process of separating the world of sound into foreground, background, important and unimportant is grossly disturbed. The ways in which hearing aids affect auditory perception is urgently in need of scientific study. Perhaps the new hearing aid equipment using two microphones, and which makes depth perception (fore-

ground-background) possible will bring untold benefits to the hearing impaired during the next few years.

Receptive Aphasia.

Another disorder which must be considered comparatively with deafness is receptive aphasia. This differs from deafness in that it is not an inability to hear but a deficiency in the interpretation of the spoken word. Like disturbances of auditory perception it is due to brain injury, but it differs from an auditory perceptual disturbance in that it is a symbolic disorder. An individual with an auditory perceptual disorder is capable of interpretation if he can organize sounds and select them appropriately from his environment. This is not true of the receptive aphasic. His basic incapacity is not one of structuring his world of sound (many receptive aphasics also are disturbed in auditory perception), but of relating the spoken word to experience. He cannot understand the spoken language symbols (speech) which normally represent the world of objects, feelings and ideas. Receptive aphasia is more common in children than has been assumed. Concepts of audiology include the need for differential diagnosis and management, both medically and nonmedically, of deafness versus receptive aphasia.

Psychic and Psychogenic Deafness.

Emotional disturbances might impede the normal reception and use of sound. Audiology has emphasized the importance of psychogenic deafness in adults, but only recently has stressed the importance of psychic deafness in children. Clinical experience and research continue to reveal that if sound becomes seriously threatening and unduly anxiety-producing, the organism suspends normal use of hearing to prevent disintegration.

For both theoretical and humanitarian reasons this is a provocative and necessary aspect of an inclusive concept in audiology. Hearing is a fundamental distance sense through which the human being acquires a unique human characteristic, the ability to speak. For this important function alone hearing has marked significance psychologically; but this is

not all that the individual receives through hearing; through it he gains feelings of well-being, identification with others, esthetic experiences, a non-directional "antennae" contact with the happenings in his environment, signals of danger and many other types of experiences such as expressions of hate, taboos, rejection, threat, punishment, hostility and fear. If one's auditory experiences generate primarily disequilibrium with the environment, then a fundamental way, even if unsatisfactory, in which to deal with the unbearable stress is to behave as though hearing is not present. Relinquishment of hearing is an indication of serious emotional disorder, and should be treated as such. Psychic and psychogenic deafness are areas requiring further emphasis collaboratively with otologists, psychiatrists, clinical psychologists, pediatricians and audiologists. Currently it appears that the most common cause of psychic deafness in children is childhood schizophrenia. In childhood it seems that such a basic organismic function as hearing typically is not relinquished for psychological reasons unless the emotional breakdown is severe and a psychosis is present. This may be in contrast with psychogenic deafness in adults, which in general seems to manifest neurotic rather than psychotic conditions.

Central Deafness.

Although central deafness is not well understood it must be included in the conceptual frame of reference in audiology, because presumably it is a factor in the reception and use of sound. Central deafness refers to impairment of the auditory pathways in the brain. This impairment impedes the conduction of the sound impulses to the interpretative areas of the brain but does not include damage to the interpretive areas themselves. (The latter condition results in aphasia.) Audiology, with the assistance of otology, neurology, clinical psychology and other sciences, is gradually making progress in the clarification of this problem with implications for treatment and training for both children and adults who present this type of auditory disorder. Experience with young children suggests that hearing for startle and other reflex behavior may be normal but that bilateral brain damage prevents conduction of sound to higher levels, so that the child is deaf for

purposes of language development. This might be one of the reasons that some children who have normal hearing by psychogalvanic audiometry are like deaf, brain-injured children clinically and educationally.

Auditory Agnosia.

Auditory agnosia is understood chiefly as a neurological disorder in adults. Clinical experience with auditory disorders suggests that it also might be important in children. It differs from receptive aphasia, deafness, central deafness and psychic deafness. It is due to gross damage to the auditory interpretative areas in the brain. The receptive aphasic comprehends non-speech sounds, such as the sound of an auto horn and the quacking of a duck. His inability to interpret sound is limited to the spoken word. The auditory agnosic, on the other hand, cannot interpret any sound normally although as compared to the individual with deafness, he can hear. Diagnosis, especially in children, is difficult; however, under careful study these patients usually manifest awareness of sound. Such awareness may be revealed more readily when a faint sound is discontinued rather than when it is introduced.

EDUCATION AND TRAINING.

Speech, Speech Reading and Reading.

Audiological concepts are changing also in regard to the education and training of both children and adults with impaired hearing. There is a new interest in the problems of teaching speech, speech reading, reading and language to the deaf and hard-of-hearing. This new emphasis has been referred to as educational audiology. Perhaps the most significant aspect of this shift in emphasis is that scientific research methodologies are being applied to these areas. Tests are being devised for evaluating speech reading success, to ascertain progress in speech development, and for evaluation of the basic symbolic process used by the deaf child; likewise, his perception, vision and other aspects of development and behavior are being studied in order to better understand the learning problems related to deafness. This includes the awareness that speech reading is a visual symbol system and that speech for the deaf might be essentially a tactile-kinesthetic symbol sys-

tem. Language teaching might require individualization on the basis of a visual-tactile approach with one individual and an auditory-visual-tactile or a visual-tactile-auditory approach with another. A deliberately planned approach on the basis of individual capacities and needs seems clearly indicated.

Assumptions have been made for techniques and methods of teaching the deaf and hard-of-hearing which have not been objectively evaluated. It is becoming possible to evaluate these assumptions with more scientific accuracy.

Auditory Training.

Auditory training is the process of teaching the individual to use his residual hearing as effectively as possible. This is done through the use of auditory training equipment and through group and individual hearing aids. Several clarifications in the use of auditory training are indicated. The limits of deafness beyond which auditory training is unsuccessful and thus unrealistic have not been well ascertained; furthermore, objectives for gradations, success and usefulness are necessary; there is considerable difference in training a person to be aware of traffic sounds and in training him to comprehend speech sounds. Clarification of the objectives and purposes of auditory training would assist the individual, and the parents, to accept limitations and not over-anticipate outcomes. The changing concepts in audiology include the knowledge that auditory training cannot be used uncritically to the maximum benefit of those with marked hearing impairment.

IMPLICATIONS OF DEAFNESS AND THE MULTIPLE HANDICAPPED.

Audiology has stressed the hearing mechanism and the use of amplification. As the concepts change the effect of deafness is being increasingly emphasized; deep concern has developed regarding the total needs and functioning of the hearing impaired person. Studies include the effect of deafness on mental development, on memory, on personality and adjustment and on motor functioning. The needs of the deaf and hard-of-hearing who are also brain-injured, mentally retarded, cere-

bral palsied or blind, as well as the needs of the aged with presbycusic deafness, are receiving increasing consideration. Such work is being accomplished with the collaboration of various allied professional groups. As this work progresses it is apparent that audiology has a responsibility to encourage counseling and programs of psychotherapy for those with auditory disorders and for their families. Such services await development in most respects.

SUMMARY.

The following are indications that the concepts in audiology are changing:

1. The field is becoming more inclusive and emphasizes all auditory disorders which affect language reception.

2. Diagnostically the frame of reference is that of auditory disorders; it is not simply testing hearing but it is also the differential diagnosis of individuals with disturbances of auditory behavior.

3. Therapeutically it is not only the fitting of hearing aids, prescribing auditory training and speech reading but is also the outlining of individualized, inclusive educational and rehabilitative programs.

4. The patient is not viewed as being only deaf or hard-of-hearing, but he is also understood broadly in terms of having sustained a sensory deprivation which affects every facet of his behavior and his relationship to his family and to society.

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AN UNUSUAL CASE OF EOSINOPHILIC GRANULOMA.

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Eosinophilic granuloma is a condition characterized by the presence of localized rarefactions involving one or more bones. Single lesions are more common in older children and in young adults, as contrasted to multiple lesions which are more common in younger children. The onset is usually insidious and symptom-free; the lesion being detected only incidentally by X-ray and after the occurrence of pathological fractures. The symptoms when present include localized pain and tenderness with swelling of the adjacent soft tissues. Leucocytosis with moderate eosinophilia may also be present. The most common sites of predilection are the bones of the cranium, pelvis and those of both upper and lower extremities; however, any bone may be affected.

The X-ray picture shows a clear cut, round or oval lesion with the overlying cortex intact and not expanded unless destroyed by the process.

Biopsy reveals the presence of a granulomatous, inflammatory lesion infiltrated by monocytes and polymorphonuclears with varying numbers of eosinophiles.

Treatment is surgical excision and Roentgen therapy, followed by rapid cure.

Prognosis must be guarded, because of the possibility of lesions appearing elsewhere in the skeletal system as well as in the skin and viscera with transition of the disease into Hand-Schuller-Christian syndrome or Letterer-Siwe disease.

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CASE REPORT.

This is the case of W. R., three-year-old male, from Puerto Rico, who was admitted for the first time at the Martland Medical Center with the chief complaint of painful swelling over the chin.

The present illness began about three weeks before admission, when the patient, while playing with his brother, received a slight blow on the chin and immediately developed pain over the area. The parents noticed swelling of the chin at this time, and the patient was brought to the hospital.

Family history was essentially negative. Past history revealed the usual childhood diseases.

On admission, the patient still complained of pain. Examination revealed slight swelling and tenderness over the region of the symphysis menti. No other contributory findings were noted.

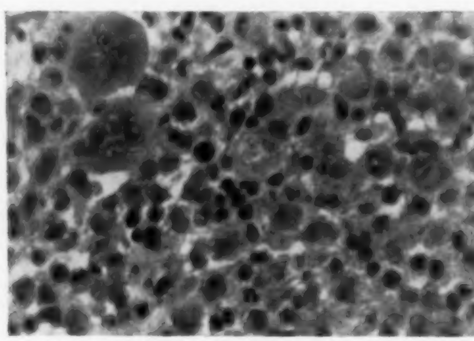

Fig. 1.

Laboratory examinations were performed. The hemogram revealed a hemoglobin 10.5 grams; red blood cells 4,350,000; white blood cells 5,050; and a differential with Neutrophils 38 per cent, Lymphocytes 58 per cent, Eosinophiles 1 per cent, Basophiles 1 per cent, and Monocytes 1 per cent. The sedimentation rate was 33 mm./hr. (Westergren); cholesterol 143 mg. per cent; calcium 9.7 mg. per cent; alkaline phosphatase 6.8 Bodansky units. Kahn was negative. Urinalysis was within normal limits. X-rays revealed a destructive process involving the anterior portion of the mandible. There was overlying soft tissue swelling. A small amount of subperiosteal bone was seen inferiorly at the anterior aspect of the mandible. The etiology could not be definitely stated from the Roentgen studies alone. X-ray of the skeleton was negative.

A surgical biopsy was performed. There were irregular, small, cystic areas in both mandibular bones in the region of the symphysis menti.

A specimen was removed and submitted to the laboratory.

The pathological report was as follows:

Section is characterized by an unusual inflammatory reaction composed of numerous large histiocytes and cells of the early immature granulopoetic series. Numerous small and large multinucleated giant cells are present, and many eosinophilic polymorphonuclear leucocytes are scattered throughout. Section is very vascular and congested. Considerable interstitial hemorrhage is present.

Fig. 2.

DIAGNOSIS: Eosinophilic granuloma.

About one week later, the wound from which the biopsy had been obtained broke down, and there was a protrusion of soft reddish vascular tissue from the wound opening, accompanied by pain and tenderness.

A large amount of soft tissue was removed, followed by curettage of the surrounding bone. Specimen was submitted to the laboratory for histopathological examination, and the diagnosis confirmed the initial impression of eosinophilic granuloma.

X-ray examinations of the mandible were taken after the operation, and no further progress of the disease was noted.

Sutures were removed on the fifth day, and the wound healed by primary intention.

CONCLUSIONS.

1. The case is considered unusual because of the following:

a. This is the first case of solitary eosinophilic granuloma of the mandible to be reported. Of all the cases in the medical literature, there are two cases that show mandibular lesions, but other manifestations of eosinophilic granuloma were present in the body at the same time.

b. A single lesion in a three-year-old child in contrast to the general opinion that multiple lesions of eosinophilic granuloma are more common in young children and the single lesion in older children and young adults.

2. It can be said that eosinophilic granuloma responds to surgery, as shown in this case.

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MEDICAL OTOLARYNGOLOGY.*

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It is a well-recognized fact that otolaryngology has for many years gradually developed into a greater medical than a surgical specialty. Perhaps the earliest transformation began with the recognition of allergy as an important cause of diseases in the nose and paranasal sinuses. More conservative surgical interference has taken precedence over the radical. More recently the introduction of the antimicrobial agents has led to a greater reduction in the necessity for surgical procedures, especially on the mastoid.

Although otolaryngology has become a predominantly medical specialty the change represents great advancement. The otolaryngologist of today must be an allergist, a bacteriologist, an immunologist, a nutritionist, a psychologist, and he must be familiar with many medical problems which are associated with or related to his specialty.

In an analysis of the data from 1,000 consecutive ear, nose and throat patients observed in 1954 by Davison[1] at the Geisinger Memorial Hospital and Foss Clinic, he noted that if minor operations were excluded, only 20 per cent of the 1,000 patients needed some type of operative procedure. The other 80 per cent required good differential diagnosis, advice concerning living habits, reassurance, minor psychotherapy and drug therapy. In the private practice of otolaryngology in which there is no close association with a hospital or a clinic, the incidence of surgical cases should be much lower than 20 per cent.

In Davison's series of 1,000 cases, some type of allergy was a factor in 22 per cent, and he expressed the opinion that it is not necessary for the rhinologist to refer these patients elsewhere for treatment. About 11 per cent of the group had vestibular disturbances and deafness. Twenty per cent had

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headaches, tension, cancer phobia, carotid pain, globus, and no ear, nose or throat disease. The remaining 27 per cent represented miscellaneous diseases such as external otitis, otitis media and conditions encountered in bronchology, etc.

The problems encountered in medical otolaryngology must be approached primarily with a complete otolaryngologic and general medical history. A history questionnaire of the type recently introduced by Anderson and Rubin[2] for allergic patients may be employed to obtain information which the busy physician does not have time to procure. The local physical and technical examinations should be thorough, including all pertinent laboratory procedures such as the cytologic, bacteriologic, radiologic, pathologic, audiologic, bronchologic, etc.

In those instances in which some closely related medical conditions may be present, as in those patients who have been referred by another physician, the otolaryngologist should extend the laboratory examination to include an X-ray of the chest, a complete blood count and hemoglobin determination, a sedimentation rate, a B. M. R., a urine examination or additional procedures as indicated. The blood pressure should be taken and a physical examination of the chest, if necessary. In many instances the otolaryngologist may establish a tentative diagnosis and thereby he may be able to refer the patient for some specific type of therapy.

The problems of medical otolaryngology are varied, multiple and ever changing. In many instances the indications for surgical interference must be evaluated only after medical treatment and observation. The management of the patient, therefore, is directed to the consideration of disease and loss of function which affect the ears, nose and throat, and related structures. These problems concern allergy, infection, immunity, anemia, nutrition, dental care, effects of tobacco and alcohol, endocrine deficiencies, loss of function as manifested by vascular headaches, vertigo and tinnitus, deafness, psychosomatic disturbances and other related conditions.

The consideration of all the subject matter can be discussed here only briefly. The recent five volume *Encyclopedia of Otolaryngology*, edited by Coates, Schenck and Miller,[3] is a com-

prehensive treatise which presents detailed discussions by leading authorities on both medical and surgical subjects. Perhaps the most important problems encountered in the practice of otolaryngology today concern chiefly allergy, infection and immunity. More recently their management has been modified to a great extent by the introduction of the hormonal agents (ACTH and Cortisones), the antihistamines, the antibiotics, vaccines, certain pharmacologic agents and more attention to secondary factors.

RESPIRATORY ALLERGY.

The diagnosis and treatment of respiratory allergy[4] must be based upon the analysis of a detailed clinical history, supplemented by the questionnaire as recently presented by Anderson and Rubin, complete local examinations and relevant laboratory procedures. This investigation will determine primarily whether the presenting problems concern nasal allergy and hay fever (with or without sinus involvement), nasal polyps, laryngeal edema, cough and bronchial asthma, external ear, Eustachian tube, middle or internal ear involvement, oral lesions and salivary gland swellings, allergic headache or local dermatitis. Only one, or a combination of these manifestations may occur. In addition, however, other associated allergic lesions may involve the gastrointestinal tract, genitourinary organs, the skin, the nervous system, the joints, the blood, the blood vessels and other structures in the body.

An analysis of this investigation or approach to the presenting problem often suggests the etiologic agents to be considered, such as: house dust, animal danders, and other inhalants as well as pollens, which commonly cause nasal and sinus symptoms, Eustachian tube involvement, cough and bronchial asthma. Foods and drugs are not common primary factors but may be secondary to the inhalants. Foods and drugs may cause middle and internal ear involvement, salivary gland swellings, laryngeal edema, headache and local atopic dermatitis. These lesions may be associated with others located elsewhere in the body; for example, in the gastrointestinal tract and in the skin. Contact allergic lesions may be located in the oral or pharyngeal cavities or on the skin of the auricles, around the mouth and the ocular regions. Other secondary factors which

concern psychosomatic, endocrine, nutritional, dental care and other states must be considered also.

Diagnostic skin tests by the scratch and intracutaneous methods may or may not reveal significant information; therefore they cannot be relied upon as the basis for treatment in the majority of cases.

For diagnosis and for determining the clinical course of respiratory allergy, frequent cytologic and bacteriologic examinations of the secretions must be made for eosinophiles, neutrophiles, epithelial cells and bacteria. Superimposed acute infections are common in allergic patients, so routine treatment must be modified frequently in the management of the patient.

Adequate management of the allergic patient begins with the avoidance or elimination of all suspected or potential etiologic factors. Specific treatment may be directed to injection therapy with house dust, other inhalants, molds and pollens, dietary manipulations and adjustment. Symptomatic treatment concerns the use of ACTH, Cortisone, endocrines, drugs such as ephedrine, antihistamines, antitussives and Aminophyllin compounds, etc.

In the markedly acute cases or in those difficult ones in which the routine therapy is not satisfactory, such as severe uncontrolled hay fever, without or with asthma, perennial nasal allergy, nasal and sinus polyposis, acute urticaria and contact atopic dermatitis, ACTH and the Cortisone (Prednisolone) compounds may be administered for a short period of time, usually one to two weeks. In most instances there is a dramatic relief from symptoms, but the good results cannot be maintained after the discontinuance of these hormones until allergic management has been adequate. In some cases, however, it may be necessary to maintain the patient on a small daily dosage for an extended period with no untoward side effects.

We usually begin therapy with the administration of 40 units of ACTH Gel or Corticotropin Z (Organon), along with an initial dose of 30 mg. of prednisolone (Delta Cortef, Meticortelone, Hydeltra, Sterane, etc.) divided into four doses: one dose after each meal and at bedtime. Subsequent daily

divided doses are usually reduced as follows to: 25 mg., 20 mg., 15 mg., 10 mg., 5 mg., 2½ mg., or less. In some instances it may be necessary to reduce more slowly at the 15 to 10 mg. levels in order to maintain relief. Finally the lowest or minimum effective dosage is established, and subsequently the use of the hormones may be discontinued. In relapses, 10 to 15 mg. daily may be sufficient. The second dose of ACTH is usually 20 units on the third or fourth day, then 10 units after seven or eight days. When the prednisolone daily dosage is small the use of ACTH is unnecessary. Non-specific stimulation of ACTH secretion may be maintained by the intradermal injection of about 1/10 unit of Staphylococcus toxoid twice weekly, along with other injection therapy.

The most dramatic results with this type of therapy are noted in cases of nasal polyps. They may disappear from the nose completely within 7 to 14 days. Local treatment with a cortisone spray may be used also in some cases. Sustained results, however, depend upon adequate allergic management. This plan of therapy is also effective in bronchial asthma and in hay fever.

Hay Fever: Most patients with ragweed hay fever present a problem of multiple sensitivities such as those to foods, molds and miscellaneous inhalants. Treatment, therefore, concerns the balanced management of all these factors which is usually very difficult in about 25 per cent of the cases. Bronchial asthma usually complicates these cases in the latter half or one-third of the season. In a group of more than 100 of these difficult cases treated during the 1955 ragweed hay fever season, excellent results were obtained in almost 100 per cent by the additional use of ACTH and Delta Cortef (prednisolone) in maintenance doses of 10 to 15 mg. daily. During the 1955 season we prescribed ephedrine sulphate in ⅛ to ¼ gr. doses for symptomatic relief instead of antihistamines, with better results. We feel that the latter drugs have a blocking effect on immunologic therapy.

RECENT ADVANCES IN ALLERGY AND IN INFLAMMATION.

From these observations it is evident that the hormonal agents play an important part in allergic management. Al-

though they do not cure the disease, they apparently attenuate or reduce the degree of sensitivity so that immunologic procedures become more effective.

The recent work of Godlowski[5] on the "Enzymatic Concept of Anaphylaxis and Allergy" sheds new light on the fundamental mechanism of these conditions. His studies concern the cellular enzymatic system, the effect of hormonal agents and the part played by eosinophiles. He demonstrates the close interdependence and causal relationship between disturbed enzymatic proteolysis and hormonal dyscrasia.

On the basis of his studies on isolated cells and exudates, Menkin[6,7] showed that the anti-inflammatory action of ACTH and Cortisone takes place at the cellular level. By suppressing the inflammatory process, certain infections may cause undue harm, but in other types of inflammation caused by non-viable organisms, such as ophthalmologic disorders or in allergic processes, these anti-inflammatory reactions may be of great value.

Menkin[6,7] points out further that inflammation is first manifested by an increase in capillary permeability and the release by the injured cells of leukotaxin, a polypeptide-like substance, which also induces the local migration of polymorphonuclear leukocytes. Inflammation is, therefore, the regulation of bacterial invasiveness. Menkin also showed that the injured cells liberate a number of various other substances which include: the leukocytosis-promoting factor (L.P.F.), the thermo stabile leukocytosis factor, the leukopenic factors (leukopenin and the leukopenic factor), necrosin, pyrexin, leukotaxin, exudin and apparently also a diffusible growth-promoting factor, or factors concerned in repair.

Cytology: In the management of respiratory allergy and infection, the routine cytologic examination of the nasal, bronchial, salivary and other secretions for the presence of eosinophiles, neutrophiles and epithelial cells is of inestimable value. More recently Bryan[8] has emphasized the significance of changes in the nasal epithelial cells, exhibited by a definite pattern of degeneration, pathogenic of virus infections such as the common cold, herpes labialis and measles. Changes characteristic of allergy may also be noted. Exfoliative cytology,

using the Papanicolaou technique, may be employed likewise in the diagnosis of malignant lesions. The interpretation of these cytologic responses and changes should be the responsibility of the otolaryngologist and should not be relegated to the pathologist. In most instances immediate diagnosis is imperative, so rapid methods of staining must be employed, using the Hansel[4] or Wright stain, especially in the management of allergy and infections.

ANTIBIOTISM AND IMMUNITY.

Although the antimicrobial agents have been indispensable in the treatment of various infections, they have introduced new problems which concern chiefly[9] hypersensitivity reactions, malnutrition, monilial infections from alterations of local flora, resistant strains of organisms, abnormal mitoses and lowered antigenicity resulting in poor antibody stimulation and alteration of the usual clinical course of infections. The development of these factors has been the result apparently of the promiscuous and unnecessary widespread use of the antimicrobial agents. The changes in the clinical pictures are characterized by the masking or mildness of the symptoms out of proportion to the existing pathology. There is often a striking absence of the resolution stage of the infectious process with a resultant prolonged stage of healing. Frequent recurrence of respiratory infections because of apparent lack of immunity, is now a common observation.

During the past three years we have been impressed with the high incidence of these persistent and recurrent infections involving the middle ear (serous otitis), the sinuses and the tracheobronchial tree. In some instances mastoid pathology may be masked by the lack of symptoms; the masked retention of pus in the sinuses may be revealed only by irrigation, displacement and/or suction. Bronchial infections persist for weeks sometimes with no general symptoms. Occasionally a mild degree of bronchiectasis or small cavities may occur in the lung, especially with Staphylococcus infections. Pulmonary bacterial infections may be replaced by monilial infections.

For the time being this presents an important problem for the otolaryngologist. It may be solved to a great extent by

employing the proper therapeutic approach. In the first place, there is urgent need for effective respiratory vaccines which may be used alone or with antimicrobial agents. By purely clinical experimentation and observation extending over a period of about 10 years,[10] we have found that certain vaccines are very effective if the material has antigenic potency, and the optimum dose is administered at the proper time intervals. Raffel[11] has recently emphasized the importance of the proper selection of bacterial antigens if satisfactory immunity is to be produced. Our initial studies began with the use of Staphylococcus toxoid in the treatment of respiratory infections and external otitis (furunculosis). In many instances of acute respiratory infection, especially when the deep intradermal injection of 1/100 to 1/1,000 of a unit of Staphylococcus toxoid was given early or at the onset, marked attenuation or complete abortion of the infection occurred.

Although these striking results were not noted in a large percentage of cases, when they did occur they were dramatic, and they are worthy of further experimental and laboratory investigation. The effectiveness of Staphylococcus toxoid was apparently due to the optimum dosage and because the infection was caused by the Staphylococcus. In those instances in which other related organisms such as Pneumococci, Streptococci, H. influenza, etc., were the cause of the infection, immunity could result from the anamnestic response or reaction. Similar and even more consistent good results have been obtained in the treatment of external otitis with 1/100 unit doses at three day intervals. Swelling and pain may subside within four to six hours.

In the vaccine therapy of respiratory infections, further studies are being conducted with Streptococcus toxin, pneumococcus polysaccharides, specific and polyvalent virus mixtures, supported by pertinent laboratory procedures.

According to the observations of Komis,[12] antibiotics suspend the multiplication and the injurious action of microbes, but do not immunize the individual against the same infectious pathogenic microorganism. He states further that the lack of natural immunity and, especially, acquired immunity are the main and only reasons for the incomplete and unstable cura-

tive action of antibiotics today. The answer to the problem is dependent upon the concomitant use of vaccines. The respiratory vaccines in use today are prepared from killed organisms. They are toxic rather than antigenic in action, so satisfactory immunity is not produced by their use. Komis has developed a method of preparation of vaccines such as those from Staphylococci, Streptococci, etc., by an alcoholic fermentation process. He has demonstrated that they are highly antigenic and extremely immunizing, as indicated by biologic, experimental and clinical methods. No local or general reactions have been noted from their therapeutic use.

The most commonly encountered problem in otolaryngologic practice today is the patient with a low grade sinusitis, serous otitis or bronchitis, which has persisted for four to six weeks or longer, beyond the normal resolution stage of seven to ten days. It is evident, clinically, that this situation is caused by lack of immunity and low antigenicity of the infecting organisms, resulting from the widespread use of antimicrobial agents and the failure to balance therapy by the simultaneous use of vaccines with antigenic potency administered in the proper optimum dosage, and within the intervals of effectiveness.

The choice of the vaccine and the antibiotic should be based upon bacterial cultures and upon *in vitro* sensitivity tests. In these cases of subacute respiratory infections, vaccine therapy alone, or combined with the use of antibiotics, should be employed along with the mechanical removal of secretions from the sinuses and tracheobronchial tree. This can be adequately accomplished by the inhalation of Alevaire (Winthrop) in the form of an aerosol, as recently reported by Miller.[13] It decreases the viscosity and dilutes the secretions so that they may be removed more easily from the sinuses by suction, or from the bronchi by coughing. In the more persistent and severe cases, inhalations should be given once or twice daily; in average cases every two days. Marked improvement or complete recovery occurs in seven to ten days. For each treatment 8 to 10 cc. of Alevaire are aerosolized within 45 minutes to one hour. During the treatment the patient is instructed to cough up the secretion several times, and in some instances

postural drainage is advisable. The apparatus employed consists of a DeVilbiss Compressor No. 501 with a No. 640 Nebulizer attachment, or the Aeromist pump with their Hi-flow Nebulizer.

In cases of tubal obstruction, Alevaire, ephedrine, antibiotics, etc., may be aerosolized and introduced into the Eustachian tubes very effectively by having the patient close the nostrils with the nasal tip attachment, then swallowing, with the aid of a mouthful of water if needed.

PRESENT STATUS OF TONSILS AND ADENOIDS.

In making a decision regarding the tonsil and/or adenoid operation, especially in children, on the basis of sore throat, frequent colds and bronchitis, allergy must always be considered as a factor. (Craft,[14] Clein[15]), Hansel and Chang,[16] found that about 12 per cent of the candidates in children had respiratory allergy. Since many of the respiratory and ear infections are now of a much milder type, and since they are more recurrent than formerly, on account of the lack of immunity, it is difficult in many instances to foretell whether the removal of the tonsils and adenoids will decrease the incidence of infections.

DRUG ALLERGY.

In the prescribing of drugs for the symptomatic relief of otolaryngologic conditions the possibilities of drug allergy,[9] idiosyncracy or intolerance always exist. Even therapeutic doses vary in different individuals. In allergic patients drug allergy may develop to aspirin, barbiturates, codeine, antihistamines, antibiotics, ACTH, etc., so it is important to recognize the fact that the patient may acquire a sensitivity to the drug administered to relieve certain symptoms.

Before administering antibiotics a careful history regarding previous untoward reactions must be taken. Serum disease reactions are more common from penicillin. Oral and gastrointestinal lesions or complications are more common with the broad spectrum antibiotics. It is also important to recognize urticaria, exfoliative dermatitis and purpura as sensitivity re-

actions. White blood and differential counts should be made for the possibility of granulopenia.

VASCULAR HEADACHES AND RELATED PHENOMENA.

One of the most common types of headache is the one described by Horton[17] as Histaminic Cephalalgia, in which the pain is usually located in the frontal, ocular and maxillary regions. The attack is often associated with lacrimation and stuffiness of the nose on the affected side. Pain in the antrum region and in the upper teeth may also be present. Since this syndrome simulates sinusitis, the patient usually consults the otolaryngologist for "sinus trouble". The attacks are not always typical of the Horton type, the onset may not be sudden, it may last for 12 to 24 hours or longer. In tension cases the onset may be more gradual, the attacks last longer and a tension factor is usually evident. Typical migraine, in our experience,[18] constitutes less than five per cent of the cases observed. Severe headaches of general type may be of allergic origin. In this type, edema of the brain occurs rather than simple vascular dilatation. Symptoms referred to the pharyngeal and laryngeal regions usually designated as "globus" may be of vascular origin.[19] Very few physicians are familiar with the management of headache problems, and since the otolaryngologist so frequently encounters these cases he should take the responsibility for their management.

In many instances vertigo and tinnitus are of vascular origin and may be managed by the same methods used in headache. Histamine, nicotinic acid, Dramamine, bonamine, etc., usually give good results, but in some cases no type of therapy may be of benefit. In severe Meniére's disease, destruction of the labyrinth may be indicated.

AUDIOLOGY.

During recent years, tremendous advances have been made in the field of audiology, especially in relation to the fenestration operation, chronic suppurative otitis media and deafness of all types. The fitting of hearing aids frequently requires

patience, skill and adequate equipment. Audiology has, therefore, become a subspecialty of otology, and it may require more time than the busy otolaryngologist has to devote to it.

EFFECTS OF TOBACCO.

Many of the problems encountered in otolaryngology are directly or indirectly related to the use of tobacco, and the otolaryngologist has the opportunity to be of great service to his patients as well as to himself. The elimination of tobacco addiction should begin with the physician himself, if he is to be successful in the management of the patient.

It is well known that tobacco with its tars and other irritants, plays an important part in the cause of cancer of the lip, tongue, buccal mucosa, pharynx, larynx, esophagus and bronchi. The toxic effects of nicotine cause nasal stuffiness, loss of smell, decrease in mental efficiency, vertigo, deafness, blindness as well as many cardio-vascular lesions.

A primary sensitivity to tobacco should always be considered in allergic patients. No patient with nasal or bronchial allergy should smoke, and the parents of children with respiratory allergy should not smoke within the household.

Tobacco smoking may cause violent attacks of coughing which may result in vertigo, syncope or cerebral hemorrhage. The bronchial irritation from smoke, with coughing, aggravates bronchial asthma. The plugging of the swollen bronchi produces areas of atelectasis and eventually emphysema, with marked chronic dyspnea and pulmonary invalidism. The otolaryngologist should play the leading part among physicians in general in the widespread elimination of tobacco addiction.

GENERAL RELATED FACTORS.

Nutrition: A significant number of patients encountered in daily practice are underweight, anemic, undernourished and have poor dentition. These factors may play an important part in allergic states, susceptibility to infection, headaches, vertigo, possibly deafness, oral lesions, etc.

Spies[21] states that more than 70 per cent of patients observed by him, with clinical evidence of deficiency diseases, present

lesions of the tongue, gums and buccal mucosa. To treat successfully patients with pellagra, scurvy, sprue, pernicious anemia, iron deficiency and related conditions, the changes of nutritional origin which affect the oral cavity should be recognized. Typical cases are rare, so the mild and atypical cases are the rule. Spies recommends dried Brewer's Yeast and liver extract for diseases caused by the deficiency of the Complex vitamins. In some instances larger amounts of specific vitamins such as vitamin C, B6, B12, folic acid and iron, or a complete vitamin supplement with minerals may be indicated.

Halpin[22] has pointed out recently that good nutrition is necessary for optimal resistance to infection and antibody production. Gastrointestinal upsets with vomiting and diarrhea cause rapid depletion of resistance. This not infrequently occurs with the administration of the broad-spectrum antibiotics, which also destroy the normal bacterial flora of the intestinal tract, with a resultant alteration or destruction of the biosynthesis of vitamins such as the B Complex and vitamin K. To combat this situation, these vitamins, as well as vitamin C, are now combined with the antibiotics. In the administration of ACTH and Cortisone compounds, nutrition is also important in the control of nitrogen balance, retention of sodium, loss of potassium, increased glycogenesis and glycosuria and the development of edema.

ENDOCRINES.

Proper endocrine balance must be a part of good nutrition. Thyroid deficiency may play a part in respiratory allergy, headaches, vertigo, etc. Estrogens, androgens, pituitary and adrenal hormones also play a part.

PSYCHOSOMATIC FACTORS.

Normal nutrition and endocrine balance may be directly or indirectly related to psychosomatic states. Allergic balance is often disturbed by such factors especially in nasal allergy and bronchial asthma.

As Davison has pointed out, many patients who consult the otolaryngoiogist have cancer and tuberculosis phobias.

They present symptoms for which there is no pathology or other explanation. In the psychologic management of all patients, assurance is important. The problem of diagnosis and the possible outcome of treatment should be explained to the patient so that he may know what to expect.

SUMMARY.

In the private practice of otolaryngology today, 80 per cent or more of the problems encountered require medical treatment. Such problems concern allergy, respiratory and other infections, the use of vaccines, antibiotics and other drugs, Alevaire aerosol, smoker's syndromes, headaches, vertigo, deafness, etc. Other supplementary factors require attention chiefly to nutrition, the endocrines, and psychosomatic states. Allergy, infections and headaches are the most important problems.

Nasal allergy and hay fever, with or without sinus involvement, must be distinguished from infection. The common cold is a frequent complication and may be diagnosed accurately only by cytologic examination of the secretion.

With the widespread use of antibiotics a situation has developed in which bacteriologic studies and *in vitro* tests are important in the selection of the proper antimicrobic agent. Since antibiotics do not produce immunity the resultant lack of it has increased the incidence of respiratory infections and has prolonged the duration of the illness. As a consequence, there is much need for vaccines with good antigenic properties and the establishment of optimum effective dosages.

Untoward reactions and complications following the use of antibiotics presents another problem which is not infrequently encountered, and which must be combined with adequate therapy and management.

As most headaches are referred to the region of the frontal, ethmoid and maxillary sinuses, the otolaryngologist is often the first to be consulted, because the patient believes he has "sinus trouble". Practically all these headaches are of vascular origin and not caused by sinus disease. Satisfactory results may be obtained in a large percentage of cases by the

administration of histamine, nicotinic acid, symptomatic drugs and consideration of tension, psychosomatic, endocrine, nutritional and other related factors.

The smoking of tobacco may account for a number of common complaints and for malignant lesions encountered in the field of otolaryngology, such as stuffy nose, loss of smell and taste, postnasal drip, cough, dyspnea, precordial pain, vertigo, tinnitus, deafness, headaches, cancer of the lip, buccal mucosa, tongue, pharynx, larynx and bronchi.

Many patients need good medical management concerning nutrition, endocrine balance, psychosomatic management and above all, assurance as to the outcome of their complaints.

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BOOK REVIEW.

L'Education de L'Enfant Sourd par les parents, avant l'Ecole. Docteur Roger Maspetiol, Docteur Michel Soule, Docteur Josiane Guillamaut, Fernand Fourgon, Marcel Gautie. ESF, 17, Rue Viette, Paris 17e. Soft cover 191 pp.

This is a comprehensive volume on the education of the deaf child. It is intended to be of help to parents and teachers.

S. R. S.

SIXTH INTERNATIONAL CONGRESS OF OTOLARYNGOLOGY.

At the request of the Sixth International Congress of Otolaryngology, the American Express Company has arranged three post-Congress tours which will begin May 11, 1957, immediately after the close of the Congress. The tours will run concurrently and each will be accompanied by an American Express Tour Escort. All three will be in Philadelphia at the time of the Sixth International Congress of Bronchoesophagology, May 12 and 13, 1957. Tours 2 and 3 will be in St. Louis at the time of the International Congress of Audiology, May 14, 15 and 16, 1957, and Tour 2 will be in Chicago at the time of the International Voice Conference, May 20, 21 and 22, 1957. Other scientific events and a full social program are planned for the major cities visited. The itineraries for the tours are as follows:

Tour 1 (Eastern U. S.): 7 days. Cost $212.00 plus $4.10 Federal Transportation Tax. Cities to be visited include Baltimore, Philadelphia, Boston and New York.

Tour 2 (Middle West): 17 days. Cost $638.00 plus $15.98 Federal Transportation Tax. Cities to be visited: Baltimore, Philadelphia, St. Louis, Iowa City, Rochester (Minn.), Chicago, Detroit, Niagara Falls, Boston, New York.

Tour 3 (West Coast): 3 weeks. Cost $838.00 plus $30.47 Federal Transportation Tax. Cities to be visited: Baltimore, Philadelphia, St. Louis, Grand Canyon, Los Angeles, San Francisco, Chicago, Niagara Falls, New York.

The prices given include transportation, Pullman and hotel accommodations, meals and handling of baggage. Individuals from overseas who purchase tours abroad will be exempt from payment of the Federal Transportation Tax.

For detailed information and complete itineraries, communicate with the General Secretary, Sixth International Congress of Otolaryngology, 700 No. Michigan Ave., Chicago 11, Ill., U. S. A.

SCIENTIFIC PROGRAM OF THE AMERICAN OTOLOGICAL SOCIETY, INC.

The Seignory Club, Montebello, P. Q., Canada,

Friday, May 11, 1956

I. *Address of President—Introduction to a Symposium On the Utricle*..........William J. McNally, M.D.

II. *Microscopic Structure of the Utricle*..........Catherine A. Smith, Ph.D. (By invitation).

III. *The Question of Cortical Representation of the Labyrinth*..........Wilder Penfield, M.D. (By invitation).

IV. *The Importance of the Otolothic Organs in Man Based Upon a Specific Test for Utricular Function*..........Ashton Graybiel, M.D. (By invitation).

V. (a) *Postural Vertigo Due to Partial Destruction of the Vestibular Nerve;*

(b) *Summary of the Symposium*..........John R. Lindsay, M.D.

VI. *Autoradiographic Studies of the Intimate Structures of the Inner Ear*..........Leonard F. Belanger, M.D. (By invitation).

VII. *Analogy Between Cochlear Fluid Motion and Formation of Surf on Sloping Beaches* (Film presentation), Jurgen Tonndorf, M.D. (By invitation).

Saturday, May 12, 1956

I. *Address of the Guest of Honor—Hearing*..........Stacy R. Guild, Ph.D.

II. *Some Recent Experiments on the Neurophysiology of Hearing*..........Robert Galambos, M.D. (By invitation).

III. *The Part Played by Psycho-Galvanic Skin Resistance. Audiometry in the Testing of Hearing of Young Children*..........Page Statten, M.D. (By invitation), and D. E. S. Wishart, M.D.

IV. *Intravascular Agglutination of the Blood: A Factor in Certain Diseases and Disorders of the Ear*..........Edmund P. Fowler, M.D.

V. *The Structure of Bone and Cartilage*..........Robert A. Robinson, M.D. (By invitation).

VI. *Functional Repair of the Middle Ear in Chronic Otitis Media*..........Professor Dr. H. Wullstein, Wurzburg, Germany (By invitation).

SCIENTIFIC PROGRAM OF THE SEVENTY-SEVENTH ANNUAL MEETING, AMERICAN LARYNGOLOGICAL ASSOCIATION.

The Seignory Club, Montebello, P. Q., Canada,

May 13th and 14th, 1956

Sunday, May 13th

A. M.

Introduction Guest of Honor..........George M. Coates, M.D.

Remarks by the President..........Bernard J. McMahon, M.D.

I. *"Humidity as Problem in Air Conditioning"*..........Arthur W. Proetz, M.D. Discussor, Lawrence R. Boies, M.D.

II. *"Histamine Releasing Drugs"*..........F. C. McIntosh, M.D. (By invitation). Discussor, Aubrey G. Rawlins, M.D.

III. *"Otolaryngologic Aspects of Hypometabolism"*......Jerome A. Hilger, M.D. Discussor, Francis W. Davison, M.D.

2:00 P. M.

IV. *"Functional Diseases of the Nose"*..........C. Stewart Nash, M.D.

V. *"Unusual Virus Diseases in Otolaryngology"*......Percy E. Ireland, M.D.

VI. *"The Virus Theory of Nasal Polyp Etiology and Its Practical Applications"*..........Francis L. Weille, M.D. Discussor papers V. and VI., L. W. Morrison, M.D.

VII. *"Management of Non-Malignant Growths in the Maxillary Sinus"*..........O. E. Van Alyea, M.D. Discussor, Robert L. Goodale, M.D.

VIII. *"Experimental Treatment of Recurrent Carcinoma of the Nasopharynx With Electrodesiccation, Radioactive Cobalt and X-ray Radiation"*..........Francis A. Sooy, M.D. Discussor, Harry P. Schenck, M.D.

Monday, May 14th

A. M.

IX. *"Ciliary Streaming Through the Larynx"*..........Anderson C. Hilding, M.D. Discussor, George Edward Tremble, M.D.

X. *"Electrical Manifestations of Recurrent Laryngeal Nerve Function"*............John A. Murtagh, M.D. Discussor, C. J. Campbell, M.D. (By invitation).

XI. *"Submucosal Compartmentation of the Larynx"* (Colored Slides)............Joel J. Pressman, M.D. Discussor, Paul H. Holinger, M.D.

XII. *"Carcinoma of the Larynx"*............Fernand Montreuil, M.D. (By invitation). Discussor, Henry B. Orton, M.D.

2:00 P. M.

XIII. *"Benign Growths of the Vocal Cord; a Critical Analysis of Pre-operative Diagnosis Compared With Microscopic Diagnosis"*............Samuel Salinger, M.D. Discussor, Francis E. LeJeune, M.D.

XIV. *"Primary Malignant Tumors of the Uvula"*............Fred Z. Havens, M.D., Richard C. Ye, M.D. (By invitation). Discussor, LeRoy A. Schall, M.D.

XV. *"Presentation of Two Laryngeal Cases"*............John B. Erich, M.D.

SCIENTIFIC PROGRAM OF THE AMERICAN LARYNGOLOGICAL, RHINOLOGICAL AND OTOLOGICAL SOCIETY, INC.,

Sheraton-Mt. Royal Hotel, Montreal, Canada,

May 15-16-17, 1956

Tuesday, May 15, 1956

(Mornings Only).

9:30

1. *Presidential Remarks*............Dean M. Lierle, M.D., Iowa City, Iowa.

Word of Welcome............Mr. Vincent Massey, Governor General of Canada.

9:40

Introduction of Guest of Honor............Harold I. Lillie, M.D., Rochester, Minn.

Scientific Session

9:50

1. *Evolution of Surgical Technique in the Treatment of Carcinoma of the Larynx* Chevalier L. Jackson, M.D., Philadelphia, Pa. (Co-author: Charles M. Norris, M.D., Philadelphia, Pa.) No discussion.

10:10

2. *Developmental and Adult Anatomy of the Auditory Ossicles in Relation to the Operation for Mobilization of the Stapes in Otosclerotic Deafness*..........Barry J. Anson, Ph.D. (Med. Sc.), Professor of Anatomy, Northwestern University Medical School, Chicago, Illinois (By invitation). Theodore H. Bast, Ph.D. (Med. Sc.), Professor of Anatomy, University of Wisconsin Medical School, Madison, Wisconsin (By invitation). No discussion.

10:35

3. *Sick People in a Troubled World*........Howard A. Rusk, M.D., New York, N. Y., Associate Editor of the New York Times, Professor and Chairman of the Department of Rehabilitation and Physical Medicine of New York University's College of Medicine (By invitation). No discussion.

11:20

15 Minute Recess

11:35

4. *A Complication of the Stapes Mobilization Operation—Motion Picture*..........Howard P. House, M.D., Los Angeles, Calif. No discussion.

11:55

5. *Some Observations on Plasma Proteins in Relation to Allergy*..........Bram Rose, M.D., Montreal, Canada, Associate Professor of Medicine, McGill University (By invitation). No discussion.

12:25

6. *Intracranial Complications of Otogenous Origin in Children Under Two Years of Age—The Role of Antibiotics*..........H. James Hara, M.D., Los Angeles, Calif.

12:45

Open Discussion.

Wednesday, May 16, 1956

9:40

7. *Structures of the Spiral Prominence and External Sulcus and Their Relation to the Organ of Corti*..........Merle Lawrence, Ph.D., Ann Arbor, Mich., Associate Professor of Physiological Acoustics, University of Michigan Medical School (By invitation). No discussion.

10:05

8. *One-Stage Repair of Hypopharyngeal Diverticulum — Motion Picture*..........Edgar S. Brintnall, M.D., Iowa City, Ia., Associate Professor of Surgery, State University of Iowa Medical School (By invitation). No discussion.

10:30

9. *Theory and Practice of Tympanoplasty*..........Professor H. Wullstein, Wurzburg, Germany, Universitats-Hals-Nasen-Ohrenklinik (By invitation). No discussion.

11:00

15 Minute Recess

11:15

10. *Automobile Fractures of the Larynx—Motion Picture* Authors, Paul H. Holinger, M.D., Chicago, Ill.; Kenneth C. Johnston, M.D., Chicago, Ill. (By invitation). Co-authors, Paul W. Greeley, M.D., Chicago, Ill. (By invitation), John W. Curtin, M.D., Chicago, Ill. (By invitation). No discussion.

11:30

11. *Tonsillectomy: Two Millennia of Hemorrhage and Controversy*..........James T. King, M.D., Atlanta, Ga. No discussion.

11:50

12. *Corrective Surgery of the Nasal Tip*..........John M. Converse, M.D., New York, N. Y. (By invitation).

12:10

Open Discussion.

Thursday, May 17, 1956
Scientific Session

9:30

13. *The Surgical Treatment of Carcinoma of the Anterior Commissure of the Larynx*..........F. Johnson Putney, M.D., Philadelphia, Pa.; Enrique A. Vicens, M.D., Philadelphia, Pa. (By invitation).

9:50

Open Discussion.

10:00

14. *Experiences With Streptomycin and Labyrinthectomy in the Treatment of Meniere's Disease*..........Harold F. Schuknecht, M.D., Detroit, Mich. No discussion.

10:20

15. *Syphilis of the Larynx—in its Protean Manifestations—Motion Picture*..........William A. Lell, M.D., Philadelphia, Pa.

10:40

Open Discussion.

10:50

10 Minute Recess

11:00

(1¾ Hour Limit)

16. *Symposium—The Operation for the Mobilization of the Stapes in Otosclerotic Deafness*.......*Moderator*—Howard P. House, M.D., Los Angeles, Calif. *Participants*—John R. Lindsay, M.D., Chicago, Ill.; Victor Goodhill, M.D., Los Angeles, Cal.; Clair M. Kos., M.D., Iowa City, Ia.; George E. Shambaugh, Jr., M.D., Chicago, Ill.; Phillip E. Meltzer, M.D., Boston, Mass.; Edmund P. Fowler, Jr., M.D., New York, N. Y. *Remarks*—Samuel Rosen, M.D., New York, New York.

Open Discussion.

DALLAS ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY.
PROGRAM 1956

Friday, May 4, 1956

6:30 P.M.—Cocktails

7:30 P.M.—Dinner—Dance

Cipango Club—3418 Gillespie

ANNOUNCEMENT.

The Mount Sinai Hospital, New York, in affiliation with Columbia University announces an intensive postgraduate course in Rhinoplasty, Reconstructive Surgery of the Nasal Septum and Otoplasty given by Irving B. Goldman, M.D., and staff, July 14, 1956, to July 28, 1956. Candidates should apply to Registrar for Postgraduate Medical Instruction, The Mount Sinai Hospital, 5th Avenue and 100th Street, New York 29, New York.

OTOLARYNGOLOGICAL POSTGRADUATE COURSE.

Saint Luke's Hospital and the Cleveland Otolaryngological Society will present a postgraduate course May 9, 1956, in Prentiss Auditorium, Saint Luke's Hospital of Cleveland. 11311 Shaker Boulevard, Cleveland 4, Ohio.

Guest speakers will be Alden H. Miller, M.D., Associate Clinical Professor of Otolaryngology, University of Southern California, Los Angeles, Cal., and Kenneth M. Day, M.D., Professor of Otolaryngology, University of Pittsburgh, Pittsburgh, Pa. Other participants in the program are H. C. Rosenberger, M.D., Fred W. Dixon, M.D., and William F. Hulse, M.D.

For further information write Paul M. Moore, Jr., M.D., Assistant Surgeon, Department of Otolaryngology, Saint Luke's Hospital, Cleveland, Ohio.

DIRECTORY OF OTOLARYNGOLOGIC SOCIETIES.

(Secretaries of the various societies are requested to keep this information up to date).

AMERICAN OTOLOGICAL SOCIETY.

President: Dr. Wm. J. McNally, 1509 Sherbrooke St., West Montreal 25, Canada.
Vice-President: Dr. John R. Lindsay, 950 E. 59th St., Chicago 37, Ill.
Secretary-Treasurer: Dr. Lawrence R. Boies, University Hospital, Minneapolis 14, Minn.
Editor-Librarian: Dr. Henry L. Williams, Mayo Clinic, Rochester, Minn.
Meeting: Seignory Club, Montebello, P. Q., Canada, May, 1956.

AMERICAN LARYNGOLOGICAL ASSOCIATION.

President: Bernard J. McMahon, 8230 Forsyth Blvd., Clayton 24, Mo.
First Vice-President: Robert L. Goodale, 330 Dartmouth St., Boston, Mass.
Second Vice-President: Paul H. Holinger, 700 North Michigan Ave., Chicago 11, Ill.
Secretary: Harry P. Schenck, 326 South 19th St., Philadelphia 3, Pa.
Treasurer: Fred W. Nixon, 1027 Rose Building, Cleveland, Ohio.
Librarian, Historian and Editor: Edwin N. Broyles, 1100 North Charles St., Baltimore, Md.
Meeting: Seignory Club, Montebello, P. Q., Canada, May, 1956.

AMERICAN LARYNGOLOGICAL, RHINOLOGICAL AND OTOLOGICAL SOCIETY, INC.

President: Dr. Dean M. Lierle, Iowa City, Iowa.
President-Elect: Dr. Percy Ireland, Toronto, Canada.
Secretary: Dr. C. Stewart Nash, 277 Alexander St., Rochester, N. Y.
Meeting: Mount Royal Hotel, Montreal, Canada, May, 1956.

AMERICAN MEDICAL ASSOCIATION, SECTION ON LARYNGOLOGY, OTOLOGY AND RHINOLOGY.

Chairman: John R. Lindsay, M.D., Chicago, Ill.
Vice-Chairman: James W. McLaurin, M.D., Baton Rouge, La.
Secretary: Hugh A. Kuhn, M.D., Hammond, Ind.
Representative to Scientific Exhibit: Walter Heck, M.D., San Francisco, Calif.
Section Delegate: Gordon Harkness, M.D., Davenport, Iowa.
Alternate Delegate: Dean Lierle, M.D., Iowa City, Iowa.

AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY.

President: Dr. Algernon B. Reese, 73 East 71st St., New York 21, N. Y.
Executive Secretary: Dr. William L. Benedict, Mayo Clinic, Rochester, Minn.

AMERICAN BRONCHO-ESOPHAGOLOGICAL ASSOCIATION.

President: Dr. Daniel S. Cunning, 115 East 65th St., New York 21, N. Y.
Secretary: Dr. F. Johnson Putney, 1719 Rittenhouse Square, Philadelphia, Pa.
Meeting: Sheraton Mount Royal Hotel, Montreal, Canada, May 15-16, 1956 (afternoons only).

AMERICAN BOARD OF OTOLARYNGOLOGY.

Meeting: Palmer House, Chicago, Ill., October, 1956.

THE AMERICAN RHINOLOGIC SOCIETY

President: Dr. Ralph H. Riggs, 1513 Line Ave., Shreveport, La.
Secretary: Dr. James Chessen, 1829 High St., Denver, Colo.
Annual Clinical Session: Illinois Masonic Hospital, Chicago, Illinois, October, 1956.
Annual Meeting: Palmer House, Chicago, Illinois, October, 1956.

AMERICAN SOCIETY OF OPHTHALMOLOGIC AND OTOLARYNGOLOGIC ALLERGY.

President: Dr. D. M. Lierle, University Hospital, Iowa City, Iowa.
Secretary-Treasurer: Dr. Michael H. Barone, 468 Delaware Ave., Buffalo 2, N. Y.
Meeting: Palmer House, Chicago, Ill., October, 1956.

AMERICAN OTORHINOLOGIC SOCIETY FOR THE ADVANCEMENT OF PLASTIC AND RECONSTRUCTIVE SURGERY.

President: Dr. Joseph Gilbert, 111 E. 61st St., New York, N. Y.
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General Secretary: Dr. C. E. Muñoz MacCormick, P. O. Box 9111, Santurce 29, Puerto Rico.
Meeting: Fifth Pan American Congress of Oto-Rhino-Laryngology and Broncho-Esophagology.
Time and Place: April 8-12, 1956, San Juan, Puerto Rico.
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Place: Army and Navy Club, Washington, D. C.

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Meeting: George Vanderbilt Hotel, Asheville, N. C., Sept. 16-19, 1956.

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Meeting jointly with the North Carolina Eye, Ear, Nose and Throat Society, George Vanderbilt Hotel, Asheville, N. Car., Sept. 17-18-19, 1956.

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Secretary of Ophthalmology Section: Richard Kratz, M.D.

Chairman of Otolaryngology Section: Harold Boyd, M.D.

Secretary of Otolaryngology Section: Howard G. Gottschalk, M.D.

Place: Los Angeles County Medical Association Building, 1925 Wilshire Boulevard, Los Angeles, California.

Time: 6:00 P.M., first Monday of each month from September to June inclusive—Otolaryngology Section. 6:00 P.M., first Thursday of each month from September to June inclusive—Ophthalmology Section.

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Meeting: April 15-19, 1956.

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Meeting: June 6-7, 1956, Chateau Frontenac, Quebec, Canada.

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Meeting: May 5, 1956.

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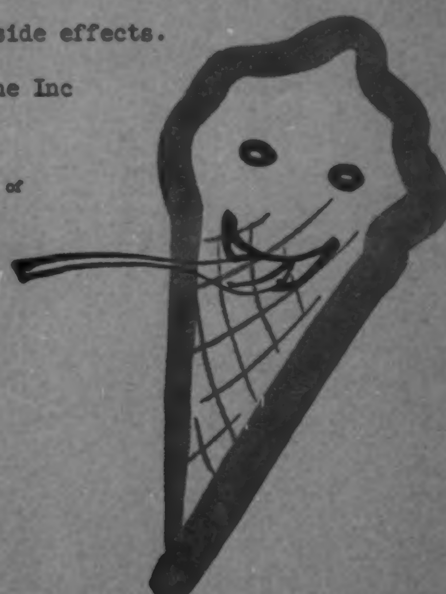

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